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Metals and Alloys

JULY 1942

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MIDLAND, MICH.

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MAGNESIUM

The Lightest Structural Metal . . . One-third Lighter Than Any Other in Common Use

VOLUME 16 • NUMBER 1 • JULY, 1942

Metals and Alloys

THE ENGINEERING MAGAZINE OF THE METAL INDUSTRIES

PRODUCTION • FABRICATION • TREATMENT • APPLICATION

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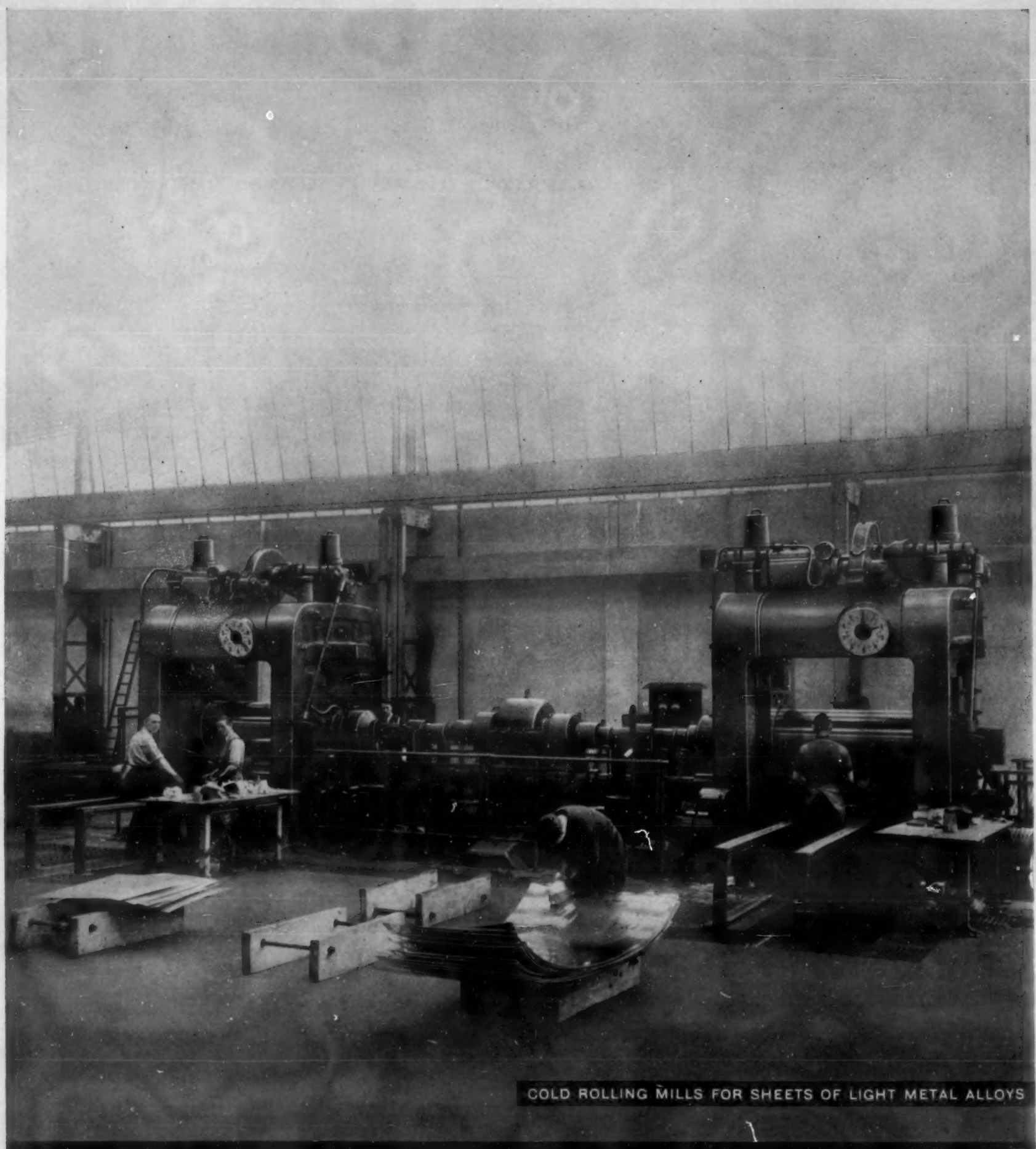

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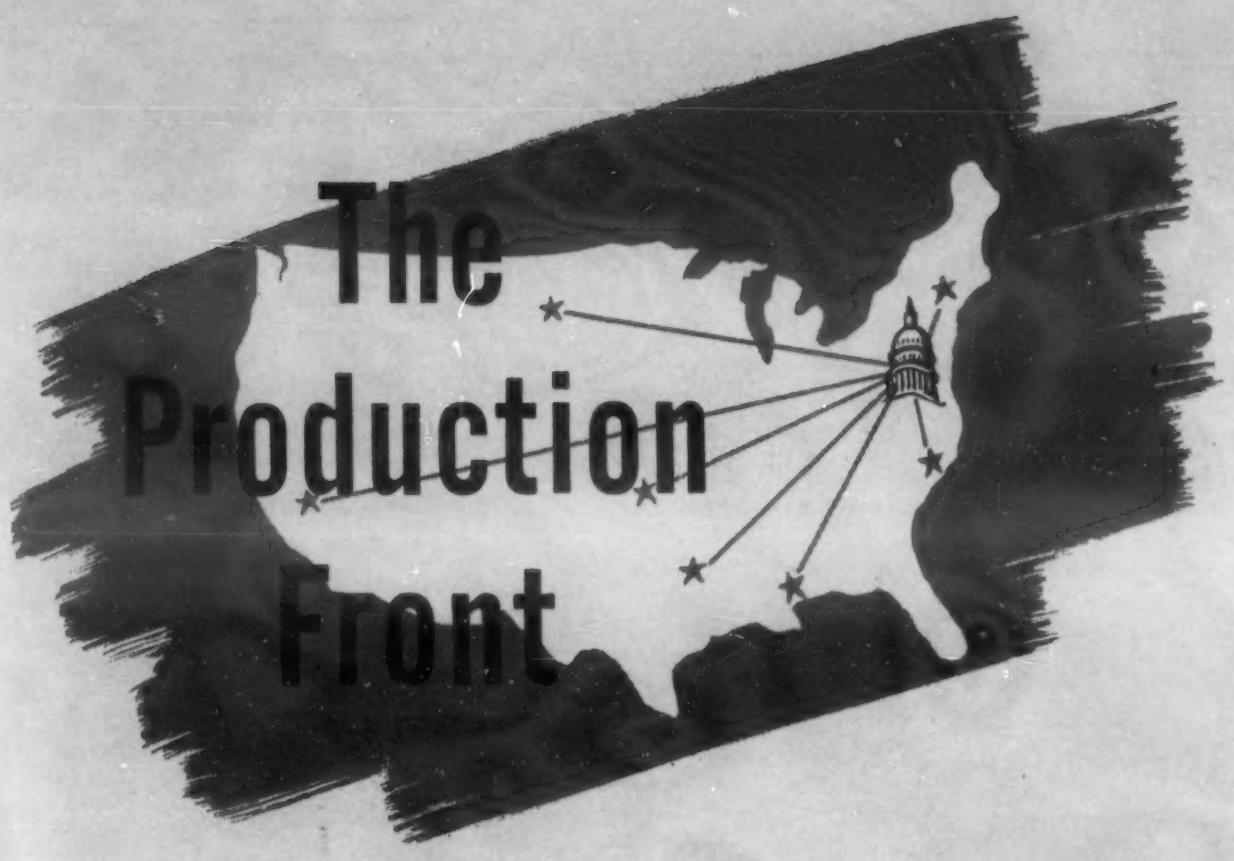


by Harold A. Knight
Associate Editor

IT TAKES A GOOD man to keep up with events, changes, trends. Pat was explaining to Mike that in Heaven a cent here is equivalent to a million dollars there; a minute here to a million years there. Mike looked very thoughtful and then: "Hey, Pat, let's play we're in Heaven—lend me a cent." "In just a minute, Mike," was Pat's sagacious reply.

Thus have time and money lost their normal values. Life over one year today is equal to 10 to 25 years normally, such is the speed of things, both as regards us as individuals and as cogs in industry and economy. And billions has replaced thousands as the common unit of financial conversation.

Paradoxically, we are moving both forward and backward at the same time. Forward, in the sense of inventions, new processes and new short cuts in industry. Backwards in that we are returning to the horse and buggy days in our private lives. Bicycles replace autos — even the Victory cycle is skimpy on metals (butt-welded, not lap-welded frames). Garage men are returning to blacksmith shops and yelling for higher priorities on horseshoe iron.

We Become Primitive

Like it or not, we are returning in many respects to primitive habits. For centuries the Chinese fashioned razors and other cutting implements from the junked horse-shoes, files and other hard irons and steels which the white man sent him. Yankee ingenuity was always a match for that of the clever Chinese, and that same ingenuity rides again.

Thus, one maker is now turning out solid hardwood truck tires, in six segments, bound together with a steel band, to be used when rubber tires are exhausted. Speeds can be but 25 to 30 miles per hour — but they at least go places.

Thrift is being cultivated as never before. We approach the status of the French peasant whose wealth was judged by the size of the manure pile in his front yard. Thus, an airplane builder harnesses up the plane being tested in a stationary manner, to provide light and power for the plant, thus utilizing to the full precious aviation gasoline.

Submarines for Transport

Inventors—real engineers and crackpots—are having a field day. There may be merit in the proposal of a senator to build gigantic submarines for freight and troops. The present war has already developed the magnetic mine, rocket shell or bomb and hundreds of technical and military secrets, many to be adapted to peace.

It has been a revelation how small peacetime manufacturers could turn to munitions making. In peace time, Army Ordnance arsenal experience is not thought of in terms of mass production. It is precision manufacture, hand-made to a large extent. Among the first to convert to war manufacture was a mouse trap manufacturer who turned out army belt buckles, army cots and bullet cores — and the world still beat a path to his door.

Dollar Sign Helped in Decimals

Pathetic and fumbling have been some attempts to convert. A maker of bronze statues in Vermont, using a water wheel for power, attempted war bronze castings but could not master the necessary decimal measurements — until the Navy Ordnance officer placed a dollar sign in front of all measurements, which lighted with understanding the eyes of the foundryman.

As tough as it may be, it is a privilege to live in these times when perhaps our whole economy, habits of thought and living are being completely reconstructed — for the better in the long run, we believe.

There are those who maintain that the materials of the future will be growing things which reproduce themselves — not those taken from the ground and exhausted. Henry Ford might be a disciple with his soybean fields for plastic manufacture. Lumber

manufacturers are not slow in promoting their products. There is even a "powder chemurgy" — items made of compressed and bonded sawdust — to match our own powder metallurgy.

Friends of the metals pooh-pooh the "growing things" theory, pointing out the ever-increasing scrap and nonperishable characteristics and the possibility of boring deeper in the earth for recovery of minerals.

Economies of movements in men and materials are being affected. Carnegie-Illinois has considered transferring men to plants nearest their homes, even where new jobs are somewhat dissimilar to old ones. Westinghouse has a staff to inspect machines for slightest incipient flaws to correct them in time — before the "Kingdom is lost for want of one horseshoe nail."

And here comes a steel maker who for the first time, in at least modern history, is making a wooden product. American Rolling Mill Co., sixth largest steel producer, is turning out wooden pipe for culverts and conduits.

WILL FERRISUL ANSWER YOUR WARTIME PICKLING PROBLEMS?

1. On high alloy welding rods for welding armor plate, Ferrisul solutions are producing a clean, fast pickle with no loss of base metals.

Ferrisul (anhydrous ferric sulfate) offers a simple and safe answer to many wartime pickling problems

Saves Metal: On 18-8 stainless steels, and many other steel alloys, Ferrisul solutions completely remove oxide scale *with no measurable attack on metals,* thus producing substantial savings in metal and chemicals previously lost in the pickling bath . . . and an ideal surface for further finishing operations. Similar savings are made on copper and copper alloys since Ferrisul solutions do not attack those metals as rapidly as do other oxidizing agents.

Safe: A mild, acid oxidizing agent, Ferrisul will not burn the skin and does not give off dangerous or noxious fumes.

Easy to Handle: Ferrisul is a dry, granular powder which takes up but a small amount of space, thus solving many storage and handling problems created by other chemicals commonly used for metal pickling. Write today for full information on Ferrisul's unique advantages and for experienced technical advice on *your* wartime pickling problems. MONSANTO CHEMICAL COMPANY, Merrimac Division, Everett Station, Boston, Massachusetts.

HELP! Prompt release of empty tank cars, carboys and returnable drums will help speed your *next* shipment of Monsanto chemicals by helping to relieve critical shortages in shipping equipment.

MONSANTO CHEMICALS
SERVING INDUSTRY . . . WHICH SERVES MANKIND

Our Tactics

Tactics continually change the form of each military front and with the change in form of this department, "The Production Front," it might be well to describe our new tactics.

Our objective is to capture the real, and sometimes elusive, gist of events and trends, by frontal attack, flank movement or parachute maneuvers. At the meeting of our board of strategy we have asked ourselves whether to record all war production developments of the month, though these have appeared in the dailies and weeklies—or, merely highlight and interpret the most significant or piquant items?

What can *a monthly commentator do? Well, he has perspective because of the longer time span. What was important to the daily columnist may be trivial under the test of time.*

We believe we can best serve, not by merely chronicling, but citing those events which are truly relevant, which signify a new trend, a new way of doing things, an important stepping stone to a new and more important event.

Our new tactics are to give the news hiding behind the news; background, a recollection of something past which might interpret the present and future.

All will be based on first-hand contact with authorities in Washington and in the field, and on avid reading.

When putting it on paper we'll remember that the observers of our assaults are practical metal men — engineers with more than a drop of humanity in their blood. We'll tell it as though you and I were in the cocktail lounge. Try to make it sparkle — like that stuff in our glasses.

So help us!

—H. A. K.

Little Fellows Get Together

Resourcefulness is shown in organization and grouping of plants for munitions manufacture. Early came the "mother hen" plant to parcel out subcontract work among the "chicks." Recently, twelve small metal-working plants in New England formed one company for small arms manufacture. A group of Vermont wood-working plants combined to manufacture and promote things of wood for our war effort.

Especially beneficial is the rapid sharing of manufacturing experience and short cuts. Fifteen engineering societies met recently at Newark, N. J., under auspices of WPB, to pass along "kinks." The strong helped the weak solve problems, and sometimes the "weak" passed on a nugget of wisdom to the strong. Such groups will meet throughout the country. Westinghouse demonstrated before technical press editors at the Hotel Astor, New York, various gadgets for improving and speeding manufacture, many of these most simple devices. A press release of the same company tabulates "17 Ways to Speed Production." Here is a typical one: For opening cotter pins: "End resembling screw driver blade is cut out, leaving two prongs, one rounded to fit eye of cotter pin, the other flattened to facilitate opening of pin. Heat-treated tool steel used."

A New Engineer—Salvage

In line with our "save your metal" program is developing a new type of engineer — the salvage engineer. The tendency is to segregate scrap at its source. The salvage engineer earns his salary many times. The scrap dealer pays more money for segregated scrap than bulk material where the lowest of quality item regulates the price for the entire batch. A moving picture graphically shows scrap recovery at the plant of the Nassau Smelting & Refining Co. — the many salvage bins and the simple chemical tests for doubtful metals.

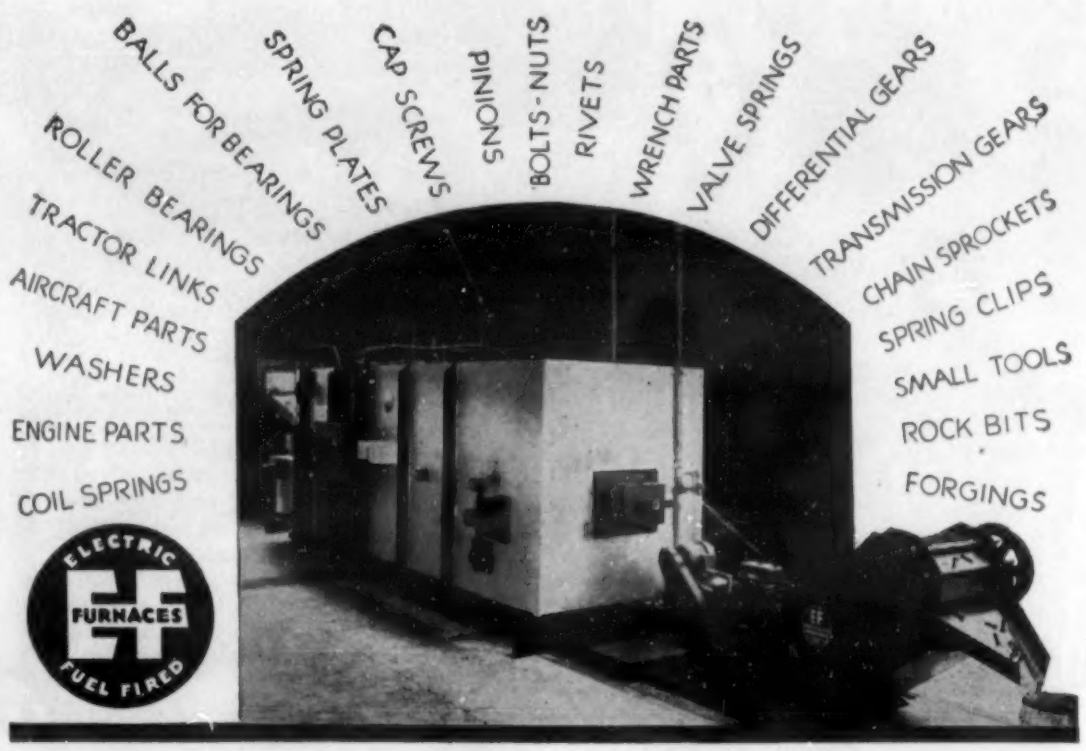
International Nickel publishes some spot tests which the non-chemist can employ. Thus the No. 1 nickel spot test distinguishes between steels containing 3½ per cent nickel; those 1 to 1½ and those, none. The chemicals give deep red, pink and brownish colors, respectively, for these three.

Those Men in Padded Cells

As time goes on there will be more and more men in padded cells for whom the word "shortage" will start spasms of hysteria and unintelligible mutterings. As A. I. Henderson, new head of the materials division, WPB, told us, shortages of materials are the No. 1, but in the same breath he stated that this is as it should be — for it means we have built up our plants and machinery to the extent expected of a progressive nation. It would be sadder if we had the materials, but not the facilities for fabrication.

One sage at Washington predicts that shortages will soon be so drastic that thousands of men in munitions plants will be laid off during the summer.

Manpower, of course, is high up among the shortages. Altogether too often the young fellow who makes the best soldier is also the most skilled workman in his manufacturing plant. Paul V. McNutt, in charge of mobilization of manpower, told us that there would be no blanket exemptions from military service among any skilled



For Hardening Machine Gun Cartridge Clips

and Miscellaneous Other Products

---300 to 1700 lbs. per Hour

. . . Investigate E F Chain Belt Conveyor Type Furnaces

E F Continuous Chain Belt Conveyor Type Furnaces are handling all kinds of products ranging in sizes from small springs and machine gun cartridge clips up to large crawler links for tanks and tractors. Hundreds of these furnaces are in operation, handling such products as listed above.

The material is loaded directly onto rugged heat resisting cast link belt conveyors. Without further attention, it is carried through the furnace, uniformly heated to the proper temperature and automatically discharged through a sealed chute to the quenching medium or directly from the furnace as desired. The chain belt conveyor returns within the furnace without cooling—no pans or trays are used in the furnace—100% net material.

These furnaces are built for oil, gas or electric heat in five standard sizes with capacities ranging from 300 to 1700 lbs. per hour. Larger or smaller sizes can also be furnished. They are also designed for using special protective atmospheres for scale-free heat treating and hardening without decarburization.

The hundreds of installations in operation, handling all kinds of material, have proven them the most satisfactory and dependable general purpose heat treating machines built for the uniform, economical, production heat treatment of miscellaneous small and medium sized parts and products.

The Chain Belt Conveyor Furnace is only one of the numerous types of production furnaces we build for various heat treating purposes.

Tank armor castings, shell forgings, cartridge cases, bomb and gun parts, aircraft and aircraft engine parts, and many other allied products are being uniformly treated in outstanding production furnaces built by the Electric Furnace Company, Salem, Ohio. We specialize in designing and building production furnaces.

Send for circulars showing these and other types

The Electric Furnace Co., Salem, Ohio

Gas Fired, Oil Fired and Electric Furnaces---For Any Process, Product or Production

trades — but that each individual would be considered separately.

Lack of trained and technically competent personnel for executives at Washington and in our war industries has been among our severest handicaps. It is well known that in the early days of our defense and war emergencies New Dealers shied away from trained industrialists — their blood was too much tainted with Capitalism, but fortunately this has been changed, though still we often have rubber men supervising steel and steel men bosses over plastics.

Washington Gives Birth to "PURP"

A gross failure had been the lack at Washington of a competent inventory of all basic materials in the country, whereas the average metal-using manufacturer knows where every pound of metal is—from receiving end to shipping room—often beyond to the warehouse and wholesaler's shelves —now in the form of finished goods.

WPB's answer to this shortcoming is Production Requirements Plan, or "Purp." At long last, materials for winning the war have been dignified by book-keeping. Essentially, PRP, (Priorities Regulation No. 11) requires all companies using $5,000 worth of metals per quarter, to file quarterly reports on Form PD-25A. About 7,000 companies already do this on a voluntary basis, with over 15,000 coming under "Purp" by the end of this June.

Decentralization

Those who write an industrial history of our war effort will undoubtedly devote much space to decentralization of plants and their thorough dispersion over the country. During the first World War munitions manufacture was concentrated along the eastern seaboard from Boston to Philadelphia.

The first rush of orders during our present emergency followed the old pattern. Between June, 1940 and September, 1941 the Pennsylvania-Delaware-Jersey area was given 8.3 per cent of all prime contracts, an area containing 5.9 per cent of the nation's population. By February, 1942, the share of contracts had fallen to 7 per cent — decentralization was in full swing.

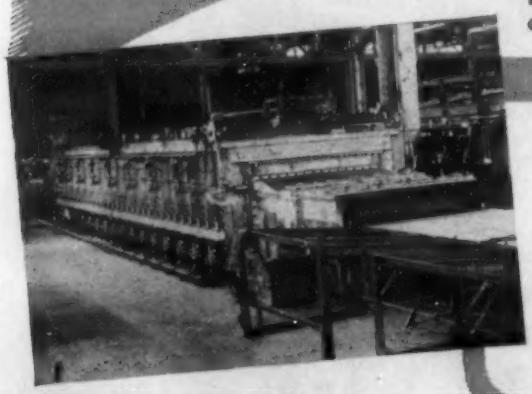
Indians Are Men of Iron

Many have perhaps shuddered at the apparent helplessness of India to defend itself against the Japs, particularly because of lack of steel and engineering facilities. However, its mills and shops are more numerous than many may realize. Present rate of finished steel production is 1,500,000 tons yearly, with extensions underway to bring it up to 2,000,000 tons. In the 1938-39 era, production was nearly 1,000,000 tons. In 1913, only 20,000 tons were produced, states British Press Service.

Indian plants are now producing a large variety of special steels, such as aircraft alloys, high-speed tool steel, nickel steel plates and acid open hearth. In the future, India will be independent of all steel imports except for some specialties. More than 1,500 workshops produce munitions, including Bren guns. Airframes are made and aircraft assembled, though air engines are not yet produced. A new motor assembly factory has been set up by Americans to supply Russia

FURNACES THAT SAY IT WITH PRODUCTION

In the heat treatment of shells and other defense products, Rockwell Furnaces speak for themselves. Here are several of the many types that say it—convincingly—in terms of production.

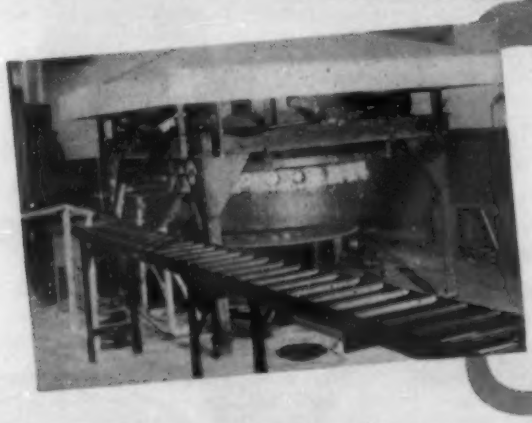


18,000 LBS. PER HOUR

This Gas Fired Roller Hearth Annealing Furnace handles cartridge brass slabs. Construction is unusually rugged — the rolls are extremely heavy, and the drive and all other parts are capable of this extreme production rate. Driven rolls carry the slabs from the charging table through preheating, heating and cooling sections, and on the discharge table to the dump mechanism.

3,000 LBS. PER HOUR

A Gas Fired Revolving Annealing Furnace (Retort Type) that is a complete unit for washing, annealing and pickling 50 caliber brass cartridge cups in a continuous, even stream. A great producer, it is also exceptionally economical from the standpoint of labor, fuel and in the use of acid.



70 SHELLS (4.5") PER HOUR

A Revolving Hearth Type Shell Nosing Furnace with openings around its outside circumference for receiving the shells. Heating is so controlled that no distortion occurs below the taper during the press operation. Charging and discharging from the same position requires only one operator—shells being sent to him on a conveyor. The absence of a water-cooled chill results in a great saving of fuel.

Because of standards already established, time-saving deliveries can be made on many types of Rockwell Furnaces that will step up your production. What is your heat treating problem?

ROCKWELL SINCE 1888 BUILT

W. S. ROCKWELL CO.

50 CHURCH STREET NEW YORK, N. Y.

with cars. Simpler types of machine tools and machinery; also, all railway equipment, including broad gage locomotives, are being made.

Drilling for Magnesium

Magnesium is one metal of which there is a great abundance—yet one has to do more than merely snap the fingers to bring it forth. Just now an interesting drilling operation is in progress at Crescent Junction, Utah. Brine from adjacent wells tested in excess of 16 per cent magnesium chloride. According to existing logs of previous drillings, magnesium salt formations should be encountered at 2,040 feet. The well now being drilled is correlating exactly with the logs of the two former tests put down at Crescent Junction.

Good Luck Omen—the Horseshoe

With gasoline and rubber like the vanishing Indian, we shift back to to horses. There is a great hue and cry for horseshoes, but companies making them in normal times are loaded with subcontracts that usually carry A-1-a priorities. Material needed for producing horseshoes carries only an A-3 rating. In 1909, shoe production was 227,476,600 lbs.; thirty years later only 20,665,000 lbs. Saddest of all — "barnyard golf," or horseshoe pitching back in good old I-o-way, may have to cease for the duration.

Personnel Changes at Capital

Bernard Campbell Gavit, dean of the law school, Indiana University, has been named general counsel of the War Manpower Commission.

W. G. W. Glos has been appointed head priority specialist, industry branches, Division of Industry Operations, WPB. Since August, 1941 he has served as head priority specialist, Production division. Walter C. Armstrong, assistant to Mr. Glos has been appointed head priority specialist for that division. J. W. Peters has been appointed to the technical consultant staff of the Bureau of Priorities.

Charles Halcomb, former chief, Products Section, Iron and Steel Branch, WPB, has become chief of the Allocations and Priorities Section, succeeding Stanley B. Adams. David Austin, executive consultant to the branch, is the new chief of the Products Section.

Joseph T. Somers, president of the Wyckoff Drawn Steel Co., Pittsburgh, has been elected chairman of the Cold Finished Bars advisory committee.

John A. Hurley, formerly general sales manager, Nineteen Hundred Corp., has been appointed chief of the Consumers Durable Goods Branch, WPB, succeeding Louis C. Upton, who returns to private life.

Walter E. Watson, vice-president, Youngstown Sheet & Tube Co., is now chairman of the General Steel Products Advisory committee, OPA.

Ivan Anderson has been made assistant chief, Special Industrial Machinery Branch, WPB, having formerly been president of Dobson-Anderson Corp.

Do You Know That—? (We Didn't)

Production of metal-working machinery is now at over $1,300,000,000 a year, or 60 per cent higher than in 1941.

Three new Government-owned aluminum plants started operations in

"Die Verdammten ROTOBLASTS!"

Here are a few of the many reasons why HITLER hates the smooth efficiency of the Pangborn Airless ROTOBLAST Cleaning machines.

1. Airless ROTOBLASTING of shells and bombs has helped many plants raise production schedules 80 to 400 per cent.
2. Airless ROTOBLASTING of armor plate for tanks and ships provides new SPEED in assembling these much needed offensive weapons.
3. Airless ROTOBLASTING of castings, forgings, heat-treated and other metal parts provides greater uniformity of surface; easier inspection for blemishes and flaws; ideal base for machine finishing or metallizing application;—*all at greater production speed and lower cost!*

NOW IS THE TIME TO ADD TO HITLER'S WORRIES BY REDUCING YOUR OWN. SIMPLY SEE WHAT ROTOBLASTING WILL DO FOR YOU.

WORLD'S LARGEST MANUFACTURERS OF BLAST CLEANING AND DUST COLLECTING EQUIPMENT

PANGBORN

PANGBORN CORPORATION • • HAGERSTOWN, MD.

May, a fourth scheduled for June, with seven new plants going Aug. 1st.

By the end of the year, expenditure for the war effort of $230,000,000 a working day will contrast with $83,000,000 last January.

Mandatory segregation of alloy steel scrap is expected to add nearly 50 per cent to amounts now recovered by steel mills.

The 80-in. hot strip mill, Gary sheet and tin mills, Carnegie-Illinois, which had a rated monthly capacity of 60,000 tons, is scheduled to produce 65,000 tons in July—and, steel plates, the mill having been converted from strips.

Rejected parts are placed on a certain table at the plant of the Grayson Heat Control, Ltd., Lynwood, Calif. Over it is a large caricature of Hirohito, grinning and saying: "Thank much, please, for helping Japanese soldier."

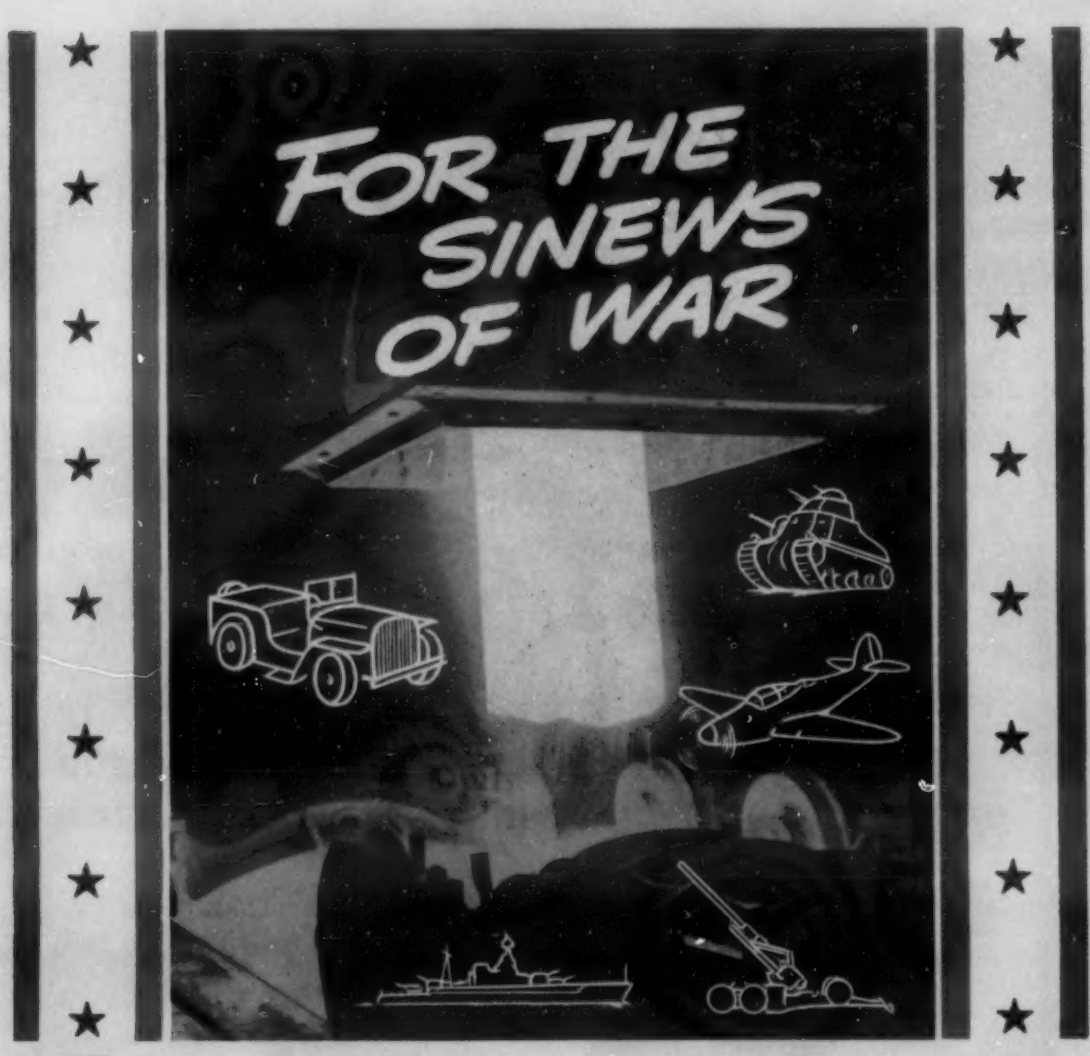
A total of 383,253 tons of scrap iron and steel were shipped out of auto wreckers' yards in May.

Consumption of iron and steel scrap in May was 4,857,000 tons, a new all-time high.

Enough extra steel every four months to build a battleship can be obtained by air conditioning a single blast furnace, Russell V. D. Dunne, Carrier Corp. engineer, told refrigeration engineers. He estimated that such conditioning of 50 blast furnaces would cause a production increase of 1,800,000 tons a year, or 10 per cent.

The "old oaken bucket" may return. WPB has ordered a 30 per cent reduction in the use of iron and steel in manufacture of pails and tubs.

Steel plate output in June totaled 1,050,962 tons, a new high, of which 489,704 tons were made on continuous strip mills. In May 1,012,194 tons were produced.



Here at Andrews every billet, bar and slab is earmarked for the sinews of war. Working around the clock, seven days a week, Andrews is solidly entrenched in the front lines in the battle of production.

And while speed is the first consideration, vigilance in maintaining Andrews quality is never relaxed. Months before conversion into billets, bars or slabs, raw material comes under the minute, exacting control of Andrews metallurgists.

This results in the complete elimination of guesswork; an unfailing guarantee of quality; the assurance that Andrews users enjoy the safeguard of a wholly dependable source of supply.

THE ANDREWS STEEL CO.
NEWPORT, KENTUCKY
DIVISIONS
THE NEWPORT ROLLING MILL COMPANY
THE GLOBE IRON ROOFING & CORRUGATING CO

Basic Open-Hearth Alloy Steel Billets and Slabs

Critical Metals Situation

Here is the outlook, immediate and future, compressed into vest-pocket size, of the chief key metals.

Aluminum. U. S. production in 1943 should reach 1,250,000 tons yearly, against 541,500 tons for 1942, and only 166,500 tons in 1939. Added to the 1943 home primary output should be considerable imports, including 225,000 tons from Canada; also much scrap from the home front. About 425,000 tons of additional capacity, authorized 20 months ago, is now in production while another 300,000 tons will be pouring ingots Aug. 1. Aluminum expansion is handicapped by scarce materials and the time element, available power and new fabricating machinery. Current expansion costs $653,000,000.

Chromium. U. S. chrome ore supply for 1942 is expected to reach 1,000,000 tons, over three times the use in 1939, and nearly equal to world production of 1939, in which year a little over 2000 tons was produced in the United States. The Government has spent $10,000,000 and private industry $1,500,000 to build up our supply, a stockpile having been started 18 months ago. Low grade ores in Montana are expected to produce 500,000 tons of 40 per cent chromium concentrate a year, with some from California and Oregon.

Copper. Domestic production and imports should reach 1,800,000 tons this year. Adding scrap, we should have available 2,100,000 tons, comparing with 800,000 tons used in 1939.

About 98½ per cent of total U. S. production is from 15 mines, the rest from 270-odd mines. The Government is spending over $180,000,000 — and industry $40,000,000 more — in 1942 and 1943 for more capacity. To stimulate production, bonuses have been paid to low grade ore producers and for over-quota production in high grade. Rigid substitutions of other materials are in motion.

Magnesium. Output in 1942 of 85,000 tons is expected with a goal of 300,000 tons in the United States. Amount of power available is the chief limitation factor. The supply from ore, brine and seawater is virtually inexhaustible. A successful process is ferrosilicon, which employs gas instead of electricity.

Manganese. WPB plans to up United States output to 600,000 tons a year, or to 20 times the local output in 1939 — all from low grade ores. Richest sources are India, Russia and Africa, with imports in 1939 of 500,000 tons, domestic production, 30,000 tons. The Government is spending $40,000,000 with industry throwing into the jackpot $6,000,000.

Nickel. The United Nations have almost entirely the world supply, though this was one of the first acute scarcities to develop. Because of liberal substitutions of other metals, the nickel situation is far from desperate.

Tin. We are depending more on conserving our supply, estimated at 14 months' on Dec. 7th, than with increasing production of this important imported metal. However, Bolivia is our trump card, and big-figure contracts have been signed. Moreover, Bolivia will furnish our sole tin smelter in Texas, Government-built, with ore to produce 18,000 tons of pig tin a year. Detinning household cans gives a very minor supply, though it could be stepped up on more urgent needs.

Tungsten. U. S. output in 1939 was 4,000 tons, but 12,000 tons will be produced yearly from deposits found in Idaho a year ago. More may come from Utah, California and Nevada, while WPB is coaxing along a supply from South America. Asia has been our usual source, with some from Russia and elsewhere. Uncle Sam was a quick-witted horse trader last December when within 48 hrs. he bought large stocks in Indo-China, put cash on the barrel head and brought it home.

Thinking Out Loud

If present fast production, short cuts and time savers are carried over into peace, theoretically—assuming a completely available market—it would be necessary for every man, woman and child to work perhaps only three or four hours a day. Moreover, we would be supplied with necessities and luxuries to an extent never before dreamed of.

There has, of course, been too much complacency about our ability to produce, as remarkable as that ability has been. More than ever, now, attention is focused on our ability to transport, which is also shaping up with astounding ingenuity. The next era will be concentrated on knack of fighting. A well-known army officer told us during a mood when he was fed-up with production complacency: "Hell, it is the soldiers who still win the battles."

BULLARD-DUNN PROCESS SHOWS THE WAY TO

BETTER AIRPLANE CONTROL

THE photograph shows three stages in the finishing of rod end bearings, used for airplane controls.

The Bullard-Dunn descaling is fast, economical, certain and free from dimensional changes. It performs a vital step in the finishing of countless parts, large and small, which are vital to the country's war effort. Write to the address below for full details and technical description. If possible, send us samples for treatment.

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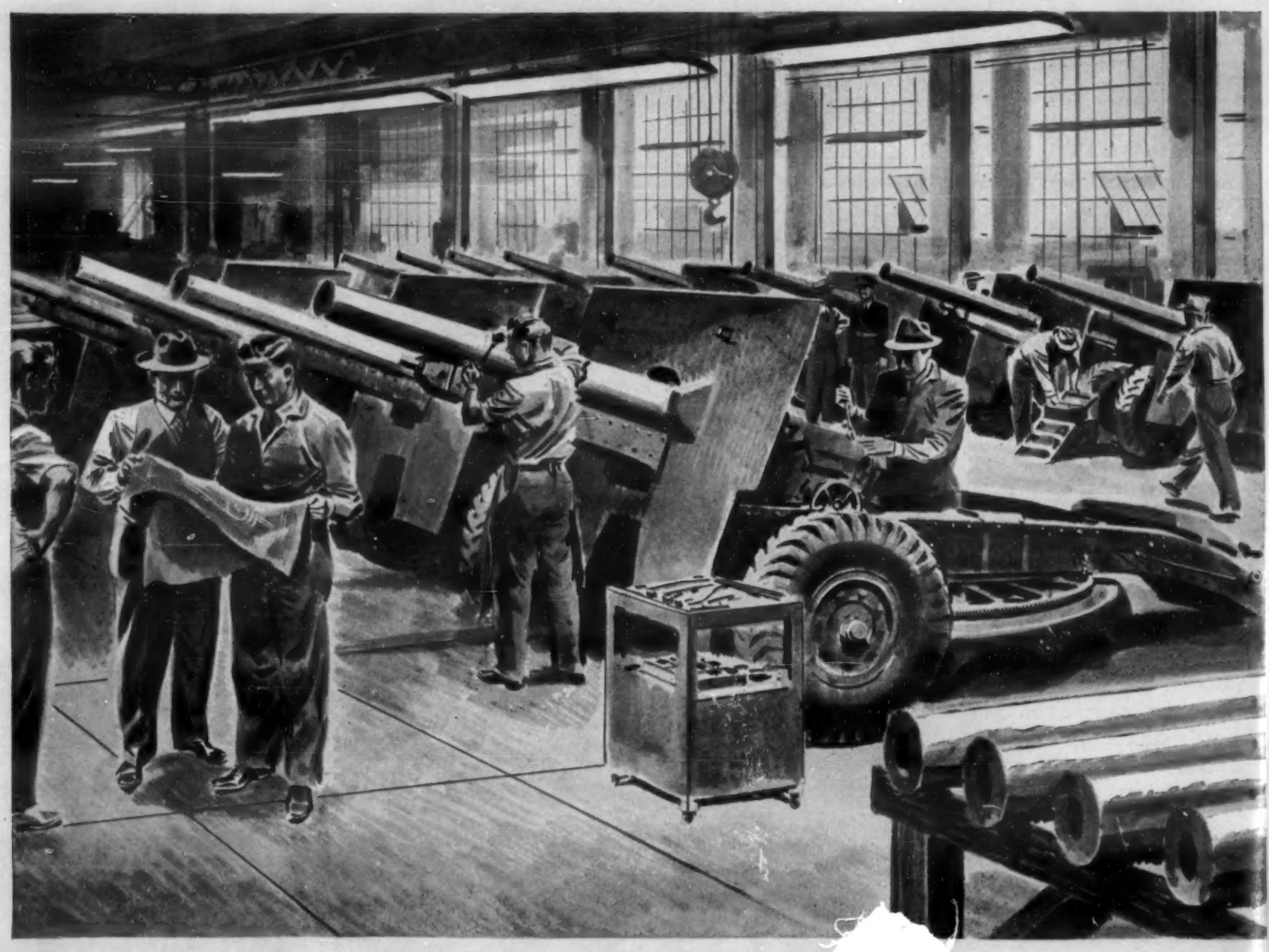
The problem:

more guns—*in a hurry!*



and GAS provides an a[illegible] with doubled, tripled production!

To fight this war successfully calls for . . . faster, more uniform, more economical production all along the line . . . so that at the earliest possible moment the guns, tanks, planes, trucks and bombs may be right on the firing-line.

It's a price everyone in American industry is only too glad to pay—because we must have victory. Anything else would be intolerable. That means that the Gas industry—with every other industry—is in this war up to the hilt.

The exacting demands of war production have given Gas a tremendous job to do all over this land . . . for production of munitions and supplies for the armed forces, for cooking their meals, baking their bread and heating water, for processing needed chemicals . . . for a hundred essential, urgent tasks. And Gas is doing the job—brilliantly!

Gas engineering has advanced in great strides during recent years. The experience, knowledge and ingenuity of the Gas Industry—plus its grim purpose to help win this war at all costs—is available to help your plant turn out more war materials—faster; to help you keep your gas equipment at maximum efficiency; to make it last longer. Why not call your Gas company—today?

AMERICAN GAS ASSOCIATION
INDUSTRIAL and COMMERCIAL GAS SECTION
420 LEXINGTON AVE., NEW YORK

THE TREND IS TO GAS

FOR ALL
INDUSTRIAL HEATING

Steel Cartridge Cases

It has long been freely bruited about that the Germans in the last war used steel cartridge cases instead of brass—that the battlefields after the war were littered with steel cases. "Why don't we do what the Germans did?" is a frequent query—and release tons of copper and zinc for other uses.

Reliable information is to the effect that the Germans did use steel cases but only to a limited extent—for certain purposes they were a failure, particularly in barrage action. The problem of the free substitution of steel cases for brass has never been licked by any nation thus far.

It can now be stated that Army Ordnance and American metallurgical engineers have practically solved this exceedingly difficult problem. And that in a few months steel cases will be substituted to a very large extent, if not wholly, for the familiar brass product.

Unfortunately for the metallurgical world, the details of this story cannot now be told—it would divulge information to the enemy. But when the information on how the many intricate problems that have arisen have been solved is released, there will result a story that will not only be intensely interesting but one that will reveal new knowledge regarding some metallurgical problems and perhaps revolutionize our fundamental conception of certain phases of the drawing of steel.

This development is certainly a metallurgical achievement of the first order. —E. F. C.

"The Plastics and Light Metals Age"

Thurman Arnold, the "trust buster" of this administration, is recently quoted as saying:

> The end of this war will see the greatest boom in history. We'll live in a new age. The Plastics and Light Metals Age. We had the stone age, the bronze age, and the iron age. Now we are going to have the Plastics and Light Metals Age.

In view of conditions that ultimately ensued after the last war and in view also of current predictions from many quarters of a severe depression after this one, Arnold's sentiments are both refreshing and encouraging. But are they prophetically realistic?

Although Arnold is a "trust buster," he is not anti-capitalistic, according to an article in *The American Mercury* by Wm. B. Huie—"Capitalism, it's wonderful. In spite of the fin-

Switch to NE Alloy Steels

to Save Critical Metals

TO HELP conserve nickel, chromium, vanadium and other scarce metals, the War Production Board's ablest metallurgists have developed NE (National Emergency) Alloy Steels. These new steels contain relatively small quantities of alloying elements in such combination as to produce physical properties usually attributed to steels of much higher alloy content. The War Production Board stipulates the use of the new NE Alloys to *replace* the standard SAE and AISI Alloy Steels for a wide range of applications.

Ryerson NE Alloy Steel stocks in six specifications, all fine grain, will be available shortly; and will consist of sizes ranging from ½-inch to 7-inch rounds, in three groups:

Carburizing Grades	*Medium Hardening Grades*	*High Hardening Grades*
NE 4023 and NE 8620. To Replace AISI and SAE Nos. A 2300, A 2500, A 3100, A 4100, A 4600, A 5100, A 6100.	NE 4042 and NE 8744. To Replace AISI and SAE Nos. A 2330-35, A 3130-35, A4130-35, A5130-35, A6130-35.	NE 4047 and NE 8749. To Replace AISI and SAE Nos. A 2300, A 3100, A 3200, A 4100, A 4600, A 6100.

Only limited data on heat-treatment response or physical properties will be available when NE Alloys are first ready for shipment. The WPB is anxious to know how these new steels will function and requests all NE Alloy users to report results in working with these new steels. Ryerson will cooperate fully with users, supplying laboratory test data, and all other available information.

• • •

If you now use Alloy steel, let Ryerson help you in adapting NE Alloys to your requirements wherever possible. Write, wire or phone the nearest of the ten Ryerson plants.

JOSEPH T. RYERSON & SON, *Inc.,* Chicago, Milwaukee, St. Louis, Cincinnati, Detroit, Cleveland, Buffalo, Boston, Philadelphia, Jersey City

RYERSON STEEL-SERVICE

agling of some of the capitalists, it can give more good things to more people than any other social system ever devised." . . . "The trouble with America is that we have been crushing that same free competition which forms the basis of a healthy capitalism. Fat monopolies have been allowed to crush free enterprise by their sheer weight and inertia. The war has afforded a chance to break up these monoplies." There are abuses by both labor and capital that need eradication.

Some will subscribe to Arnold's philosophy but others will feel that unrestricted competition is not for the greatest good of the greatest number.

The anti-monopolists generally forget that the large, strong organizations that have been built up when circumstances of quais-monopoly existed, have done the long-term research that made expanded production of nickel, aluminum, magnesium, molybdenum, etc., quickly possible for war use, and showed how best to utilize them. Had production been scattered among a dozen small, weak competitors, the sum total of knowledge might have been more widely scattered, but less. The knowledge is being freely passed on for the good of the country today. We should be fair in this connection.

Arnold's prediction regarding the "age" we are to live in should be at least partially true—with developments in plastics intense both as regards new uses and also substitution for metals and with production of the light metals aluminum and magnesium, skyrocketing to astonishing totals, our post-war age may be one of "Plastics and Light Metals."

But that doesn't necessarily mean that the heavy metals will be displaced to any great extent. The strength of steel, the corrosion resistance of copper, the die-castability of zinc, will still be assets not to be disregarded. Plentiful supplies and low prices of the light metals and plastics will give the designer the economic possibility of choosing from a wider range of raw materials. But he isn't going to make rolls for rolling mills out of magnesium. We should keep our shirts on in this connection.

—E. F. C. and H. W. G.

Building Blocks

A vast change has come over organic chemistry since we studied it. At that time organic chemistry was the production of pure products of definite chemical composition according to a definite reaction. Nowadays organic chemistry is quite as much concerned with the concocting of materials of certain mechanical properties by blending of molecules used as mechanical building blocks, not as chemical reagents. Large molecules of irregular contour are used to twist around each other to produce textile fibers, and to jam together to produce plastics. Various plasticizers are used in plastics, in paints and varnishes, etc., as equivalents on the basis of their mechanical behavior. In a wide range of uses, a whole group of wetting agents of widely different chemical composition are interchangeable on the basis of mechanical effects. Many other cases could be cited; that is, the art of organic materials has gone beyond chemistry, even beyond physics, into mechanics.

The same sort of thing is occurring in metallurgy. In steel there is replaceability, within limits, of one carbide forming element for another and one ferrite-strengthening element for another; attaining a certain metallographic structure is of vastly greater importance than the particular chemistry and heat treatment by which it is obtained. In the mild-alloy steels for use without heat treatment, many different compositions of ferrite-strengtheners can be selected to give broader equivalent engineering results. In quenched and tempered steels, the conventional alloying is primarily for depth-hardening. The alloying elements are really used for such effects, and it is these effects rather than any one of several compositions that give the effects, that are the goals.

(Continued on page 78)

Industrial Uses of Silver

Broadening Rapidly

by A. M. SETAPEN

Development Engineer,
Handy & Harman, New York,
formerly Research Engineer,
Amer. Silver Producers Research Project

In the last year silver has assumed the position of an outstanding substitute metal, replacing copper, nickel, chromium and zinc in a host of applications for which those metals cannot now be obtained. For many of these new uses silver will undoubtedly continue to be employed when the emergency has passed, since it has often shown itself to be better for the job than the material for which it was substituted.

It is not generally realized that a large proportion of these successful "substitutions" could not have been so quickly achieved if the technical groundwork had not been laid during the last few years—in other words, if the Silver Producers' Research Project had not been in existence to explore the engineering properties and possibilities of silver and investigate potential new applications. This article is a summary of these developments, and gives a broad picture of silver's new industrial position and the technical reasons therefor. —*The Editors.*

A DECADE OF RESEARCH has already increased the industrial use of silver to many million ounces annually. Last year (1941) alone saw certain important industrial uses doubled. Up to the end of 1939 there were no less than 500 patents issued in the United States dealing with the uses of silver, not to mention a large number of foreign patents. The rate at which patents pertaining to silver are being issued is rising sharply, indicating that industry is becoming cognizant of the industrial importance of this metal.

Leading companies interested in silver have carried on extensive research for many years. Numerous potential industrial uses have been studied and many are now in production. The American Silver Producers' Research Project, sponsored by a number of leading producers, was organized to expand the uses of silver. Their investigations have included, not only the operation of several research projects in American universities and technical schools and in at least one Government Bureau, but they have compiled references to the work of hundreds of other investigators of silver applications. A summary of their program and its accomplishments, together with data and information on the properties and industrial applications of silver, appears in the recent book, "Silver in Industry," (edited by Lawrence Addicks, and published by the Reinhold Publishing Corp.). About one-fifth of the 600 pages in this volume is devoted to a bibliography of publications and reports on silver which have been studied and to which hundreds of references are made.

It is planned in this brief article only to mention some of the results secured and point out a few of the ways in which research is bringing about wider industrial uses of silver. The excellent properties and characteristics of silver warrant its consideration for many uses and particularly during these times as a substitute for strategic or scarce materials. A perusal of the particulars given here should suggest many possibilities to the active mind.

Alloys of Silver

Researches referred to have, in the first place, brought to light numerous alloys and mechanical mixtures containing silver. In most instances it will be sufficient to merely mention the different alloys, together with their uses. For convenience, these will be discussed alphabetically.

Aluminum-silver alloys have been studied experimentally and a composition containing about 8 per cent Al, after proper heat treatment, has a Brinell hardness number as high as 225. A silver addition to *aluminum-silicon* low expansion piston alloys has been suggested, since greater hardness is obtained and retention of hardness and strength at elevated temperatures may be expected. *Beryllium-copper-silver* alloys are finding some application in industry and are important because they can be heat treated.

Cadmium-silver alloys are useful in solder and electrical contacts. These solders have advantages over common lead-tin solders because they possess good strength at both elevated and room temperature. *Cadmium-copper-silver* alloys are used in bearings but are attacked by some lubricating oils if the bearings operate at too high a temperature. An electrolytic coating of indium is said to overcome this difficulty. Sintered mixtures of *silver and carbon,* especially graphite, find extensive use in electrical contacts and brushes. An alloy of *chromium-copper-silver* is said to be stronger than some kinds of steel. It can be used practically for fuse clips in high tension switching devices.

Alloys of *copper and silver* are in widest use although the binary alloys find chief application in silverware and coinage, not here considered as "industrial uses." A small percentage of silver in copper materially raises the annealing temperature, making it possible to braze and solder without undue softening, as in commutator bars, and to process engravers' plates. Less than 1 per cent of silver in copper yields an alloy of high electrical conductivity and one useful as a welding rod. Data secured on the improvement of *copper-nickel* alloys by the addition of *silver* in small percentages are such as to warrant commercial investigation. About 3 per cent of silver in wrought alloys of copper (bronze) containing 5 to 10 per cent Sn renders them susceptible to precipitation hardening. The heat treatment increases yield strength markedly without significant decrease in ductility. Silver can be partially substituted for tin in the higher tin bronzes without much change in the properties.

Gold in amounts of 20 to 30 per cent is alloyed with *silver* for use in electrical contacts and an alloy containing 70 per cent Au, 6 per cent Pt and 24 per cent Ag is much used in telephone contacts. An important use of *magnesium* base alloys containing *silver* may be developed for aircraft applications. An alloy containing: 5.5 per cent Ag, 2.6 per cent Al, 2.6 per cent Zn, 0.2 per cent Mn and the remainder magnesium has a specific gravity of only 1.89 and has a tensile strength up to 65,000 lbs. per sq. in. in extruded bars. Certain alloys of *magnesium and silver* are used in electrical contacts.

Spot welding electrodes for aluminum have been made from 40 per cent Ag and 60 per cent Mo; and other alloys of these metals are used in electrical contacts. *Nickel* is only slightly soluble in *silver* and in silver rich alloys it refines the grain and increases the hardness. Nickel is considered very beneficial in silver alloys for electrical contacts. Some *silicon-silver* alloys are remarkably resistant to corrosion and, as silicon is inert and improves the physical properties of silver, uses in the chemical industry have been suggested. These alloys are susceptible to heat treatment. Sintered *tungsten-silver* mixtures are useful in electrical contacts, as well as certain *zinc-silver* alloys.

The tendency of silver to raise the annealing temperature of alloys seems to be rather general. This influence is most pronounced in binary alloys. It is weaker with increases of a third element, such as zinc in brass and tin in bronze. Very small proportions of silver often have an important effect in reducing corrosion or other chemical attack. Silver moderately increases the hardness of such soft metals as aluminum, copper, lead, magnesium, tin and zinc. Silver often produces a grain refining effect in alloys and may be expected to create a tendency toward restriction in grain growth.

Researches on low-temperature bonding of silver by heat and pressure only (as distinct from brazing and welding) have shown that silver is superior in such bonding to all other metals except gold. Properties which combine to account for such bonding include nobility, plasticity, and low temperature of recrystallization after work hardening. Strips of silver heated to 400 deg. C. in an electric furnace and rolled together in such a way as to effect a 50 per cent reduction in area, formed an adherent bond. Similarly, silver plated steel showed an improvement of bond when subjected to moderate heating. Rolling produced a better bond than pressure alone at elevated temperatures. Copper, nickel and steel are among the metals to which silver can be bonded with or without using a brazing alloy to form "silver clad."

Hydraulic press set up for compressing powdered mixtures containing silver, before sintering is done.

Apparatus for observing the compressed powdered mixtures containing silver as they undergo sintering and checking the temperatures attained.

Silver Clad Metals

Much research has been conducted on the production and possible application of silver clad metals and during the present emergency silver clad steel is finding extensive use as a substitute for stainless, nickel and other scarce metals and alloys. The excellent corrosion resistance of silver, together with the high strength of the steel backing, produces a combination of properties in a material for vast utility. The joining of pure silver and silver clad metals by welding requires skill, but is successfully done. The bond to produce the cladding is commonly effected by rolling bars, which previously have been cleaned carefully, fluxed and heated to the required temperature. In some instances this temperature can be lowered if a thin sheet of low temperature silver brazing alloy is sandwiched between the silver and the metal to be clad.

Silver-Brazing Alloys

A great number of low temperature silver brazing alloys has been investigated, their silver content varying from 5 to 80 per cent. Excellent joints are made with these, at temperatures varying from 1175 to about 1600 deg. F. and by proper design of the joints, it is possible to secure a strength greater than that of the metals joined. As the strongest joints are only a few thousandths of an inch thick, very little brazing alloy is required. Silver brazing alloys in thin strips, sheets and in small wires have been made available, as the research has resulted in the development of brazing alloys which are ductile and readily worked. One of the most widely used of the silver brazing alloys flows at 1175 deg. F. and produces high strength, leak-tight, ductile, low-cost joints with ferrous, non-ferrous and dissimilar metals. High speed production is possible with this material.

Another important brazing alloy, having a flow point of 1300 deg. F., produces high strength joints on non-ferrous metals only. Because of the low flow points of these two brazing alloys, parts being joined are not objectionably softened and in many instances heat treatment is maintained. They are now being used 100 per cent in war production. Any one of the several methods of applying heat is feasible.

Low Temperature Alloys

Several soft solders containing 2½ to 6 per cent Ag with the balance chiefly or entirely lead have been investigated. They melt at 579 deg. F. to slightly above 700 deg. F. and are recommended for use in place of lead-tin solders when their higher melting point is not a hindrance. Solders containing as much as 5 per cent Ag with the balance lead have a metal value about the same as a 50-50 lead-tin solder. Those alloys having smaller percentages of silver cost less than many tin-lead compositions and constitute alternatives for the tin solders. Claims, such as lower melting point, better wetting and greater fluidity, are made for lead-silver solders containing small percentages of antimony, bismuth, tin and others. Lead silver anodes are extensively used for electrolytic production of zinc.

Bearings

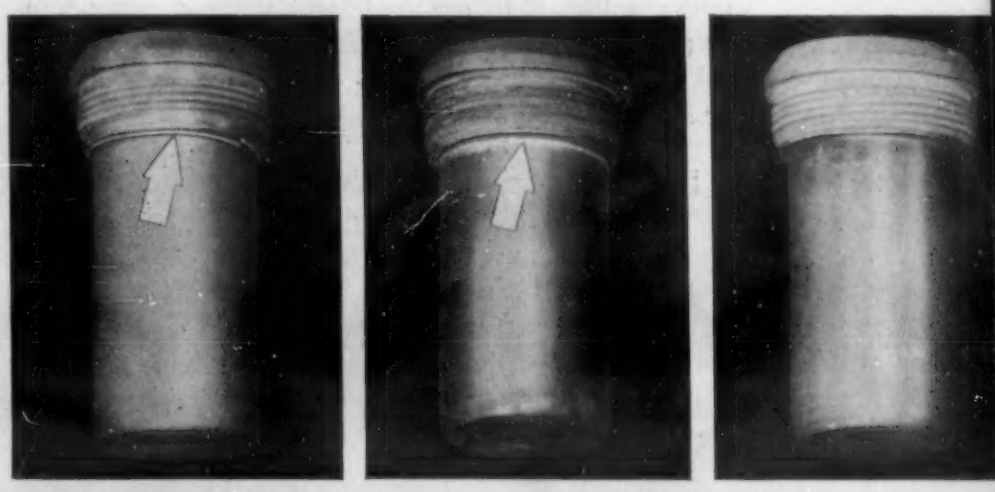
Investigations conducted by the Research Project have shown highly encouraging results with aircraft engine bearings of steel heavily plated with a lead-silver alloy containing about 3.5 per cent Pb. Such bearings are more seizure resistant than those plated with pure silver and possess greater oiliness. Bearings high in silver content are exceedingly resistant to corrosion and are capable of carrying higher specific loads at higher speed than babbitt, lead-copper or bronze bearings. Aircraft engine bearings, having steel backs coated with pure silver or high silver alloy, are now in extensive production for aircraft engines. Experiments in plating such electro-deposited pure silver bearings with lead and indium (presumably in preference to silver-lead alloys applied to the steel back and with no subsequent coating) have been made, but reports thereon have not been made available for publication. Silver additions are being made to lead base babbitt metals to improve their performance and these are being considered as substitutes for tin-base alloy bearings.

Coatings

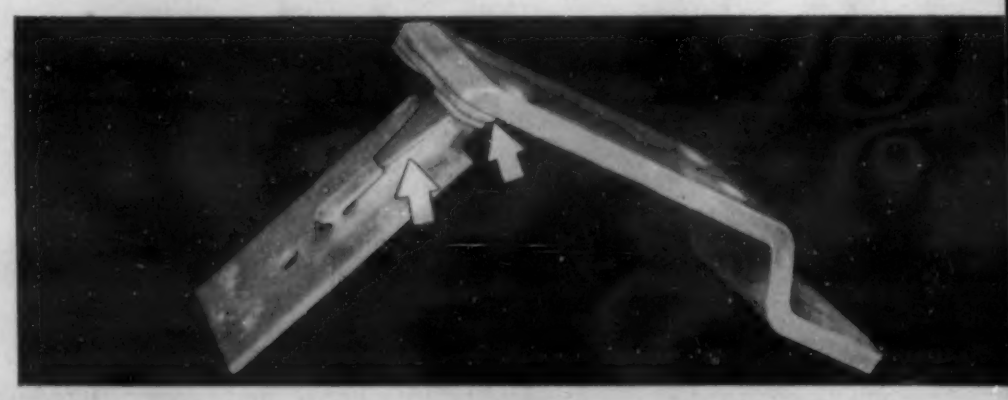
Electrolytic and other coatings of silver for other purposes than bearings have been the subject of extensive research. Except where the high corrosion resistance or some other properties of silver are essential, this coating must be exceedingly thin to com pete with the different types of coatings.

Deposition of very thin films of silver by chemical reduction, especially on glass for common mirrors, is widely done. Chemical reduction is not easily adapted to rapid production on a large scale, though some speedy spray applications have been developed. Deposits ranging from poor to excellent are possible on plastics and also on metals. Thin

Laboratory equipment for experimental brazing in a muffle type furnace including a pyrometer for indicating the temperature in the furnace.



Exploders for 3-in. trench mortars as they appear before and after assembly with silver brazing alloy. Arrows point to ring of brazing alloy wire placed around the joint before heat is applied and to the smooth joint formed as a result of the brazing. Third view shows assembly after it has been tinned and lacquered.



Electrical contacts made from silver alloy are secured to this assembly by silver brazing alloy having high electrical conductivity.

silver deposits are obtained by vaporization. Scientific control and rapid production are much more rapidly obtained than in chemical reduction which is sometimes classed as an "art." Bright, adherent deposits are readily obtained by vaporization on many materials, including glass and plastics, metals and foils. They are not free from porosity, though perhaps as nearly so as any silver film of *equal thickness.*

Steel coated with copper can be plated with as little as 0.0001 in. of silver and some such deposits are reported to be "pore-free to the steel base." Plating solutions substantially free from suspended matter, clean steel surfaces and great care in handling are necessary to secure these thin, pore-free silver deposits. Deep-drawing steel coated with 0.001 in. of copper or nickel, followed by a 0.001 in. pore-free coating of silver, can be drawn without injury to the coating. Coatings of this kind are being recommended for returnable type containers, used in handling different materials and this is receiving definite attention by the industry. Steel plated with copper and silver can undergo extensive reduction by rolling after plating, with annealing between rollings, if required, and without separation of the plate.

Miscellaneous Applications

It is well known that silver, in some cases, acts as a catalyst in promoting certain chemical reactions, such as vapor-phase oxidation of alcohols. An objection has been the relative instability of silver *at high temperature.* It has been shown, however, that the rare-earth, oxide-promoted silver catalysts can be used successfully over long periods and that the silver surfaces become stabilized. It is thought that further work along these lines may lead to extensive use of silver as an oxidation catalyst.

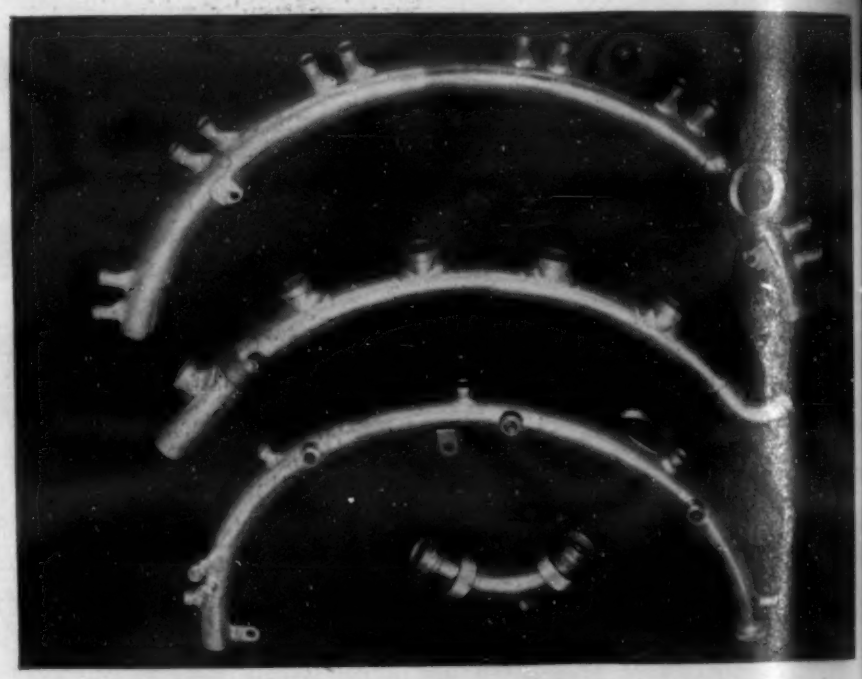
Silver's high resistance to corrosion is founded chiefly on its high degree of nobility. Only gold and platinum are higher in the electropotential series. Film formation on silver is rarely of importance in inhibiting the corrosion of silver and users thus need not be concerned with breaks in any films formed. An exception, however, is the formation of the protective film of silver chloride which rapidly develops when silver comes in contact with chlorides. The protective nature of this particular film is quite important.

Research on the corrosion of silver has been so extensive that an attempt to summarize the results in a paragraph is futile. Use in contact with acetic acid has been extensive, as have been applications in the photographic, dyestuff, rayon and other chemical industries. Applications in contact with phenol, formaldehyde, hydrofluoric acid and concentrated caustics, among other chemicals, are either extensive or considered promising.

Many years of research have been devoted to the discovery of means for preventing the tarnishing (chiefly the formation of sulphide film) of silver and silver alloys. Although certain degrees of success have been attained, none has been sufficiently successful to gain extensive use, sometimes in part because the color or appearance resulting is considered inferior to that of fine or sterling silver.

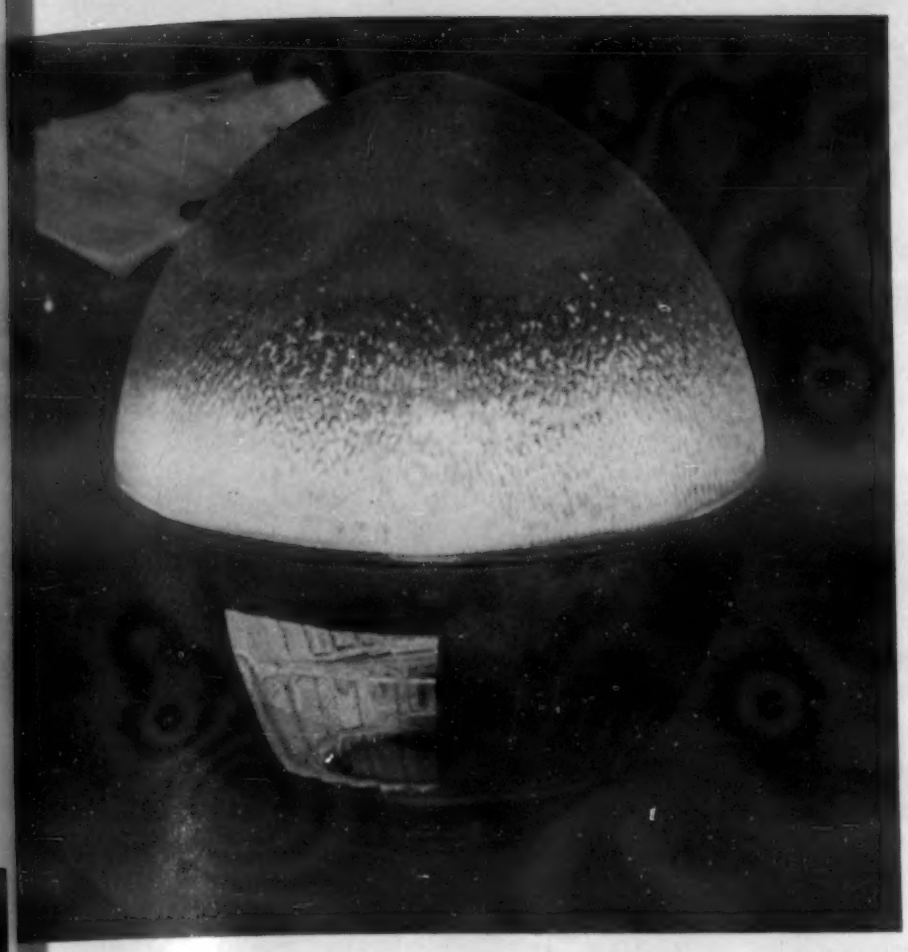
Silver in Powder Metallurgy

Extensive research into the possibilities of silver in powder metallurgy has been conducted. Some of the resulting alloys or mechanical mixtures are sufficiently ductile to be rolled and drawn into wire and even made into small parts which can be peened or riveted. The chief uses to date have been in electrical contacts. As a matter of fact, electrical contacts afford one of the large potential uses of silver and extensive research and development have demonstrated the great utility of silver and silver alloys for this purpose. High conductivity for both heat and electricity; low contact resistance (promoted by high corrosion resistance and the relatively high conductivity of sulphide films); the tendency of any oxide formed to loose its oxygen and return to pure silver when heated, and the ability of silver to alloy or form good mechanical mixtures with other metals and with carbon are among the properties which account for the extensive use of silver in contacts.



Radio shields for aircraft engine ignition wires. All joints are made with silver brazing alloys and are far stronger than joints would be, made with soft solder.

Among the alloys or mechanical mixtures based on silver which have proved beneficial in contacts for specific types of service are those containing one or more of the following: Copper, zinc, nickel, tungsten, molybdenum, carbon, cadmium, manganese,



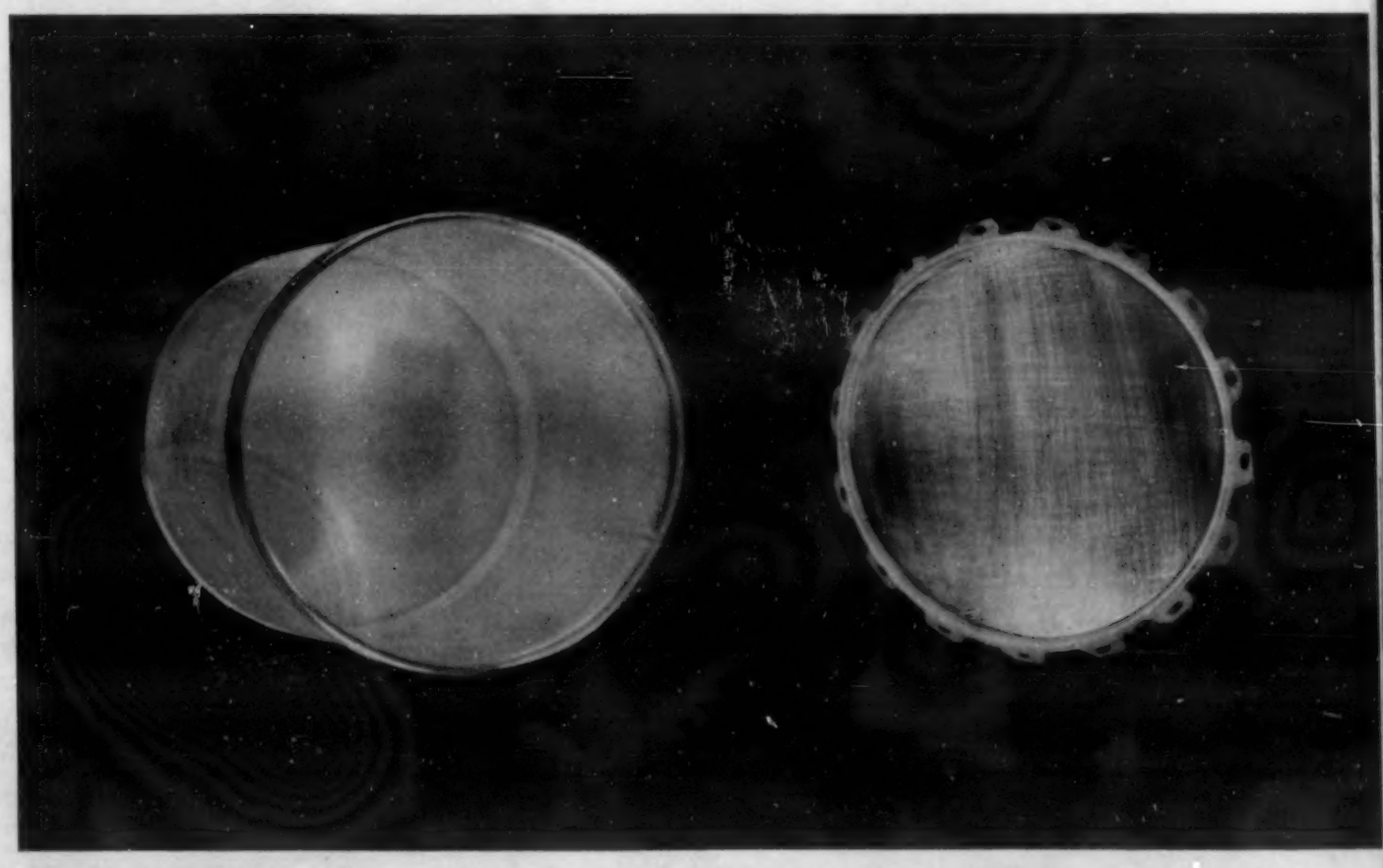
(Above) New General Electric luminaire for street lighting with one-piece glass globe, the reflecting surface of which (seen through window) is coated with silver, affording a higher reflectivity than the aluminum formerly used.

sulting in lower operating temperatures, decreased wear, lower voltage drop and, in some cases, less tendency to score.

With powder metallurgy practice, it is a simple matter to make a porous product by including in the powdered mixture an ingredient which is volatilized at or below the sintering temperature. It is too early to predict what may eventuate along this line but it can be said that silver is well adapted to use in a wide variety of mixtures readily produced from powdered materials.

Mere mention of the germicidal properties of silver or its possible use in fungicides is sufficient here. Silver has been applied in sanitation, sterilization and pasteurization. It has been employed in the sterilization of water and for the preservation of such products as fruit juices and beer. Silver is considered an almost perfect chemical disinfectant for substances in contact with humans and animals. Because silver is markedly toxic to *pathogenic organisms,* it is believed that practical fungicides based upon it will be produced.

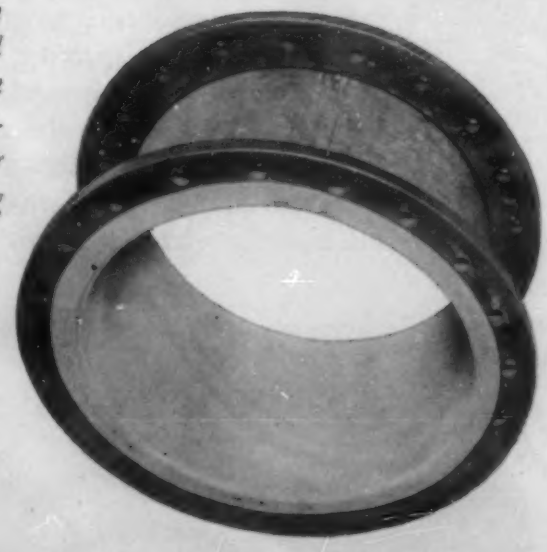
Industry is rapidly coming to realize that silver is good for a host of uses outside the arts and for every-day jobs which are often done better with silver than with any other metal.



Bucket and cover, both lined with silver and designed for use in the chemical industry under conditions where high corrosion resistance is needed.

gold and platinum. Some of these increase hardness and wear resistance; others reduce any tendency to stick or weld as a result of arcing. Other research has demonstrated the utility of silver in moving contacts and especially in brushes in which silver is mixed with graphite. Among the advantages secured are lower internal and contact resistance, re-

Section of a column made from silver-clad steel. The interior joint is welded with pure silver and the exterior joint with steel welding rod.



Dilatometric Equipment

from The Lunkenheimer Co., Cincinnati

per H. E. MONTGOMERY and J. W. BOLTON

For checking critical points of steels and for determining the thermal expansion of production and experimental alloys, the ideal dilatometer would combine direct reading with accuracy and sensitivity. A dilatometer with these features and its applications for determining both thermal expansion coefficients and critical points are described in this article. Its components include a quartz tube and rod in a specially designed furnace, a special bracket device, Selsyn motors, an extension recording device and a recording potentiometer controller.

—The Editors.

THE DILATOMETER DESCRIBED HEREIN combines accuracy, reasonable sensitivity, and the advantages of direct reading, as an autographic chart. It was devised after consideration of the various advantages and disadvantages of commercially available devices. It is direct reading, on rectangular chart or graph and does not require calibration bar to calibrate temperature scale or to calibrate expansion of supporting mechanism.

It has three ranges of expansion and contraction sensitivity as follows: 1 in. on chart equals 0.0008, 0.0016 and 0.0032 in. per in. of 5-in. specimen. These ranges compare very favorably with commercially available devices. It has somewhat more open temperature scale, 1 in. equals 110 deg. F. (Others range from 180 to 250 deg. F. per in.)

Diagram of setup is given in Fig. 1. The quartz tube "D" and the rod "B" are essentially the same as described in Fig. 2, page 708, A.S.T.M. Standards, Part I, 1939, in connection with Standard Test for Linear Expansion of Metals, B-95-39, except that a specimen 1 in. longer (i.e. 5 in. long) is used. The specimen does not necessarily have to be 5 in., it can be any reasonable length desired if indented "V" supports are so spaced.

The furnace "K" is essentially the same in principle as that described by the authors in June, 1934, issue of METALS AND ALLOYS, pages 127 and 128. The feature of this type furnace is the series of external leads by which it is possible by total or partial shunts to accurately control temperatures at desired locations throughout the used length. For our purpose a furnace 4½ in. in diameter and 20½ in. long is used.

A number of calibrations show that it is readily possible to maintain maximum variations in temperature along the length of the specimen of ±1½ deg. F. or less at any constant temperature in the range 500 to 1000 deg. F. and ± 5 deg. F. at temperatures to 1600 deg. F. The furnace is mounted at a 45 deg. angle, which is slightly less than the angle recommended in B-95-39.

The bracket "C" and devices and setup to translate motion from "C" to the recording device were conceived by H. Montgomery and developed by him and J. Urban, of the Lunkenheimer Co. Research Laboratories. These are shown in diagram Fig. 1.

The recording mechanism used is an adaptation of a Southwark Templin stress-strain recorder used on a Baldwin Southwark testing machine. For laboratories having this kind of equipment and only occasional dilatometric tests the changes necessary for combined use as a stress-strain recorder or as a dilatometric recorder are very easily made as shown in Fig. 1, the only change necessary is to extend the recording drum shaft and hook it direct to the central shaft of a pyrometer, such as the Leeds & Northrup instrument used. The revolving of the drum indicates temperature instead of stress. If individual equipment is desired it would be possible to make this setup using the Selsyn motors etc.

How the Equipment Operates

The operation of the equipment in detail is as follows: As the specimen "A" expands, the quartz rod "B" pushes against the sliding contact "G" forcing it further into the Invar bracket "C" which is rigidly fastened to the quartz tube. When contact "G" touches contact "H" which screws into bracket "C," it actuates the solenoid "D (1)," throwing one of the gears in the reversing gear train "P" in contact and driving shaft "A". Motor "N" runs continuously. The recording pen is driven across the

chart and simultaneously the Selsyn motor F-2 is driven through the gear train "L". Gear train "L" is used for changing sensitivity of the expansion scale. Selsyn motor F-2 in turn actuates Selsyn motor F-1 causing the threaded contact "H" to screw out and thus break contact. This immediately breaks the solenoid "D (1)" current and all recording is stopped until the specimen expands further. A movement of less than one ten thousandth of an inch is sufficient to break the electrical contacts.

There is no lag or coasting in the Selsyn motors. For measurement of contraction of the specimen the electrical mechanism is so arranged that a breaking of contact between "G" and "H" actuates solenoid "D (2)" thus moving the pen and the Selsyn motors in the opposite direction from above. If it is desired to follow both expansion and contraction as through critical points the electrical hookup is fixed so the mechanism cycles back and forth as the contact at "G" and "H" makes and breaks. This is called "tick-tock" by some people.

The recording drum is connected by a shaft to the potentiometer recorder "J". A calibrated chromel alumel thermocouple "E", fastened directly to the specimen, is connected to the pyrometer, and any change in temperature of the specimen results in the rotation of the recording drum. The pyrometer scale is such that 1 in. of chart equals 110 deg. F. This enables one to read the temperature on the chart to $\pm$ 2 deg. F. The temperature can also be checked at any time by connecting the thermocouple directly to a semi-precision potentiometer. This enables one to read the temperature to 1 deg. F. or less. The recording paper is blocked off in 1-in. major divisions with 0.1-in. minor divisions. The temperature scale does not correspond with these divisions so it is either necessary to mark off on the paper the major temperature points or to have special recorder paper made up.

The expansion recorded by the dilatometer is the difference between the expansion of the specimen and the corresponding length of quartz tube which is adjacent to the specimen. As the temperature rises, the whole system in the furnace expands. However, since contact "G" is fastened to the quartz rod and contact "H" is connected to the quartz tube by means of the Invar bracket "C", the difference between the expansion of the quartz tube and the combined expansion of the quartz rod and specimen are recorded. As both the rod and tube are made of quartz the difference of their expansion is negligible as has been determined in calibration tests. This leaves the difference between the expansion of the specimen and the expansion of the section of quartz tube adjacent to the specimen to be recorded.

The quartz tube containing the specimen has about two-thirds of its length in the furnace. The temperature at the top of the tube remains practically unchanged during the test and, since the exposed parts are either quartz or Invar, the variation in length of the exposed parts is negligible. To make certain that this possible source of variation is negligible an expansion test was run on a quartz specimen. With a quartz specimen the recorded expansion should be zero, since it has the same coefficient of expansion as the tube. Actually a maximum expansion of 0.00015 in. was recorded on heating the 5 in. quartz specimen to 1000 deg. F. Since this is as close as one reads the chart, it can be neglected.

As the specimen is heated, the recording drum rotates, recording the temperature, simultaneously the difference between the expansion of the specimen and the quartz tube is recorded by the horizontal motion of the pen, giving a curve of expansion vs. temperature.

Calculating the Results

To determine the coefficient of thermal expansion, from the expansion curve, it is only necessary to read the expansion between the two desired temperatures from the expansion curve, add the expansion of the section of quartz tube adjacent to the specimen, and divide by the temperature difference and length of specimen.

Fig. 1. Diagram of the setup of the apparatus.

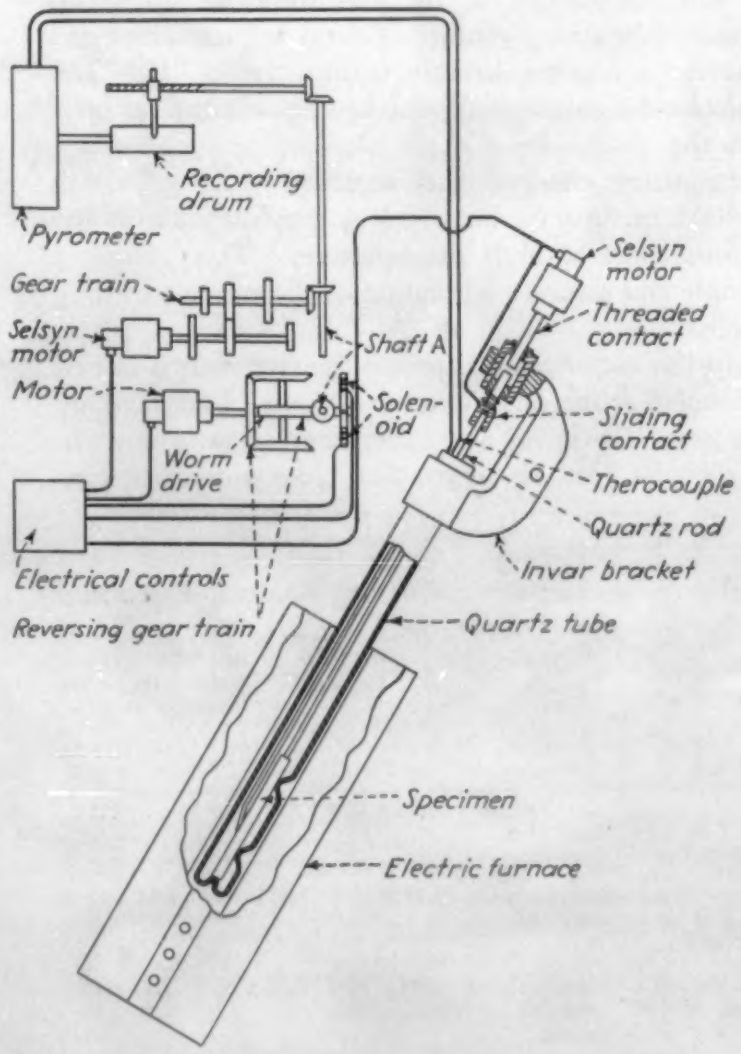


Table I—Linear Coefficients of Thermal Expansion for Non-Ferrous Alloys.

Alloy	Treatment	Average Coefficients—in. per in. per deg. F. 80—350 F.	80—600 F.	80—750 F.
Copper	Rolled	9.42×10^{-6}	9.80×10^{-6}	.....
Rod brass....	Rolled	10.70×10^{-6}	11.29×10^{-6}	.....
ASTM B60-36	As cast	9.96×10^{-6}	10.26×10^{-6}	.....
ASTM B61-40	As cast	9.72×10^{-6}	10.09×10^{-6}	.....
Nickel	Rolled	7.31×10^{-6}	7.83×10^{-6}	8.15×10^{-6}
Rod monel "R"	Rolled	7.74×10^{-6}	8.19×10^{-6}	8.35×10^{-6}
Cast monel ...	As cast	7.98×10^{-6}	8.29×10^{-6}	8.56×10^{-6}

Example—for a 5.005-in. specimen—Fig. 2

8.68 div. equals 0.03472 in. expansion recorded between 92 and 1000 deg. F.

908 F. by 5.005 in. by 3×10^{-7} equals expansion of section of quartz tube between 92 and 1000 deg. F.

0.03472 plus 0.001363 equals 0.036083 in. total expansion of specimen between 92 and 1000 deg. F.

Coefficient of expansion equals $\frac{0.036083}{5.05 \times 908^\circ}$ equals 7.94×10^{-6} in./in./°F.

This gives the average linear coefficient of thermal expansion between 92 and 1000° F.

Photograph of an actual chart record is shown in Fig. 2. As may be noted the expansion increment is offset at the maximum temperature on cooling so that there will be no conflict of the expansion and contraction curves. This makes for more accurate reading of the charts. Tables I and II show some values on various materials.

The calibration of the recording mechanism is checked by fixing contact "G" on a micrometer and moving it a given distance against contact "H". The micrometer readings are checked against the readings on the chart. In a check test the reading of the micrometer checked the recorded reading within 0.0001 in. in 0.04 in. which is the full scale of the 10-in. chart at high magnification. This affords a simple and accurate calibration of the entire recording mechanism.

In the use of the equipment the specimen is heated or cooled at the rate desired by means of an auxiliary rheostat. Obviously for faster cooling rates quenching media may be used. For close automatic controlled heating or cooling rates within the limits of the furnace, an auxiliary drive attached to the temperature setting dial of the recorder may be used. This drive is actuated by the recorder motor through a suitable integral contained gearing arrangement normally used for constant rate of strain or load application.

Table II—Linear Coefficients of Thermal Expansion for Cast Steels.

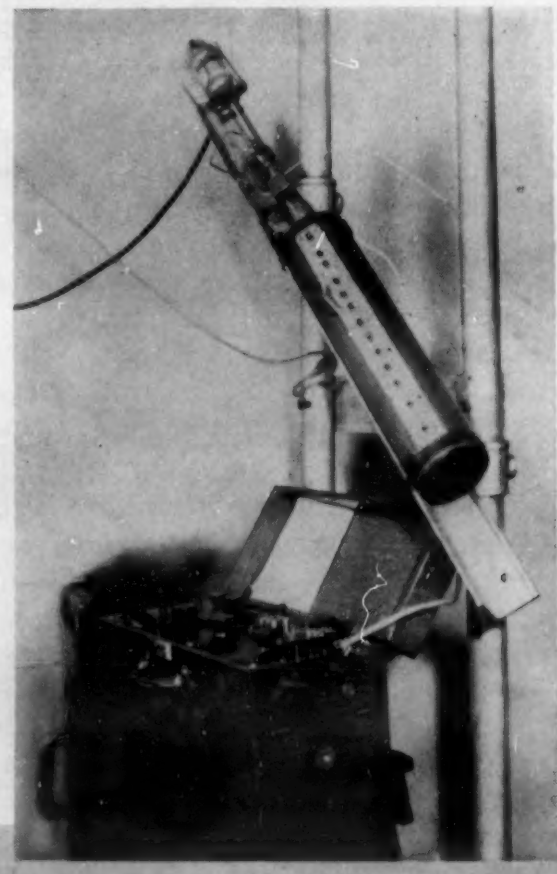
Alloy	Treatment	Average Coefficients—in. per in. per deg. F. 80 to 750 F.	80 to 950 F.	80 to 1050 F.
Carbon steel, ASTM 216-39T WCB	Cast, normalized and drawn	7.56×10^{-6}	7.81×10^{-6}	.....
Carbon moly. ASTM 217-39T WC1	Cast, normalized and drawn	7.51×10^{-6}	7.80×10^{-6}	7.91×10^{-6}
Ni-Cr-Mo Steel, ASTM 217-39 T WC4	Cast, normalized and drawn	7.44×10^{-6}	7.70×10^{-6}	7.82×10^{-6}

Determination of Critical Points

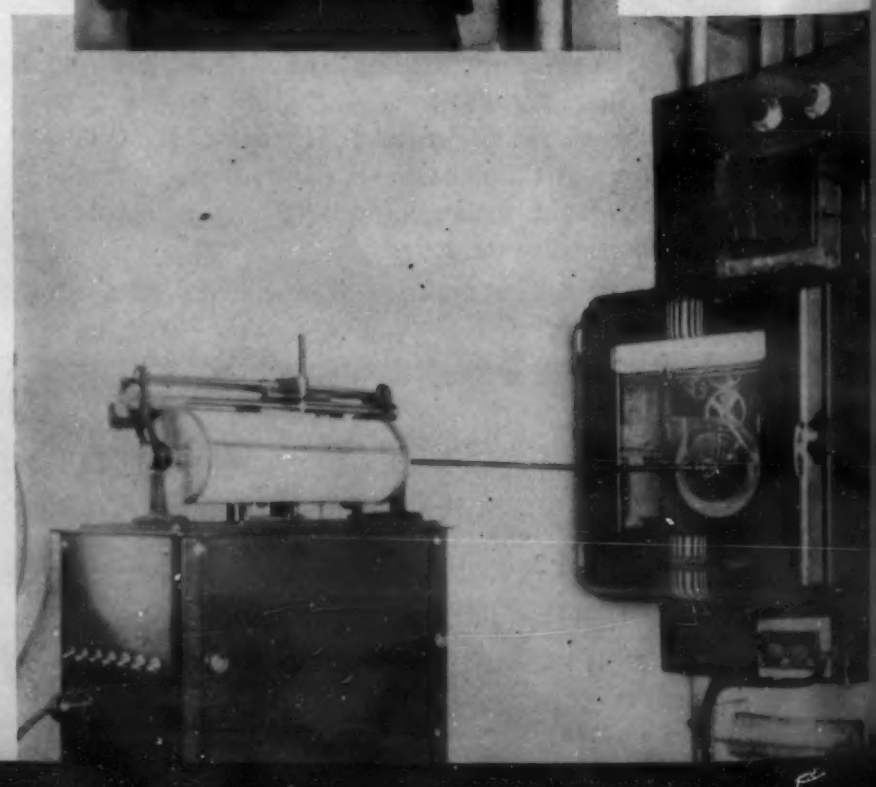
In the determination of critical points, cycling of the recorder is necessary so that the recorder will follow both contraction and expansion as the critical points are approached. Cycling may be dispensed with if an attendant watches the curves and, as a critical point develops, the necessary change is made in the electrical switches to follow the expansion or contraction through these points.

Figs. 3 and 4 show curves obtained in the determination of transformation points on a 12 to 14 per cent Cr steel with approximately 0.35 per cent C. Two different cooling rates were used, resulting in a split transformation (Fig. 4) and a suppressed trans-

A part of the equipment.



Another view of a portion of the apparatus.



formation (Fig. 3). Fig. 5 shows the heating and cooling curves on a cast carbon steel (A.S.T.M. WCB). These curves were recorded originally on a more open scale and were redrawn for compactness and to switch the axes to follow the conventional practice of having the temperature read on the abscissae scale.

The maximum speed of heating or cooling for critical point determination is limited by the speed of expansion recording and the speed of the pyrometer in following temperature changes. In our equipment the maximum speed of pen travel for recording expansion is 10 in. (total chart) per min. The actual maximum rate of contraction or expansion would of course be regulated by the length of sample and magnification desired. With a 5-in. specimen and the least magnification (0.0032 in. per in.), the recorder will follow a maximum expansion or contraction of the specimen of 0.16 in. per minute. The maximum rate of temperature change the pyrometer will handle will of course depend upon the individual instrument, its scale, cam shaft speed, etc. Our pyrometer will handle a maximum of 500 deg. F. per 15 secs. This however does not allow time for accurate balancing and much slower heating or cooling rates are desirable when using it. We understand, however, that one of the instrument companies has come out with a pyrometer that will follow and record accurately up to 500 deg. per sec.

Necessary Precautions

Two major but simple precautions are observed in obtaining accurate and reproducible results. These are the positive seating of the specimen in the tube and the maintaining of clean contact points at "G" and "H", Fig. 1. These points are easily kept clean because they are platinum tipped.

In the use of this direct reading equipment the coefficient of expansion and critical points on several hundred specimens have been determined. It has proved simple, positive and demands a minimum of skilled attention. Many checks have established its accuracy and dependability.

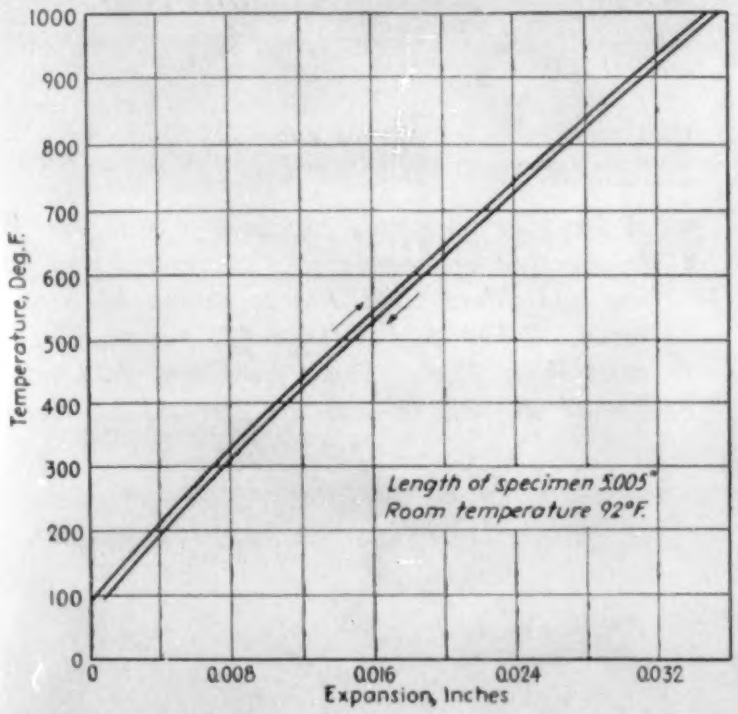


Fig. 2. Thermal expansion curve for alloy steel bolting material, A.S.T.M., designation A 193-39T, Grade B-13.

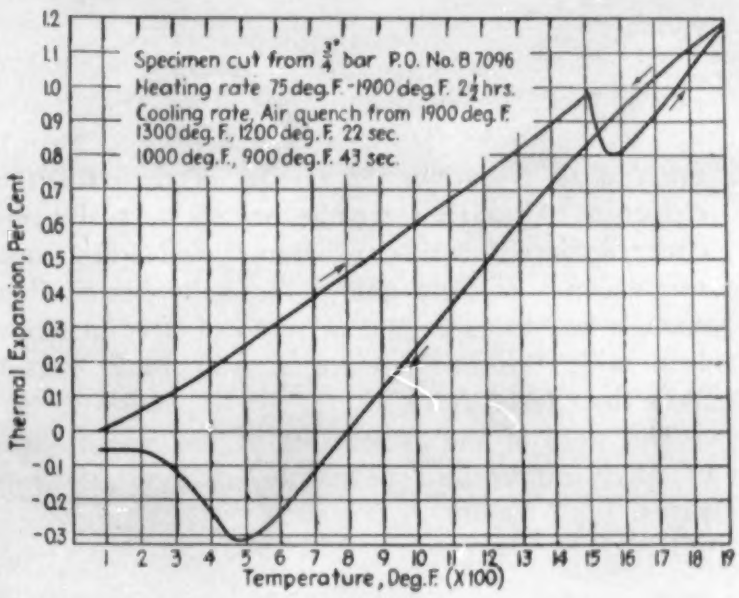

Specimen cut from 3/4" bar P.O. No. B 7096
Heating rate 75 deg. F. - 1900 deg. F. 2½ hrs.
Cooling rate, Air quench from 1900 deg. F.
1300 deg. F., 1200 deg. F. 22 sec.
1000 deg. F., 900 deg. F. 43 sec.
Thermal Expansion, Per Cent
Temperature, Deg. F. (X 100)

Fig. 3. Thermal expansion of stainless steel, 420 type.

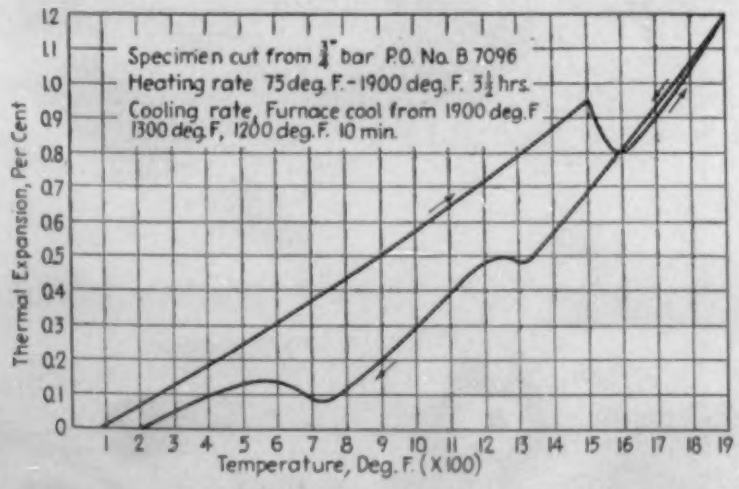

Specimen cut from ¾" bar P.O. No. B 7096
Heating rate 75 deg. F. - 1900 deg. F. 3½ hrs.
Cooling rate, Furnace cool from 1900 deg. F.
1300 deg. F, 1200 deg. F. 10 min.
Thermal Expansion, Per Cent
Temperature, Deg. F. (X 100)

Fig. 4. Thermal expansion of stainless steel, 420 type.

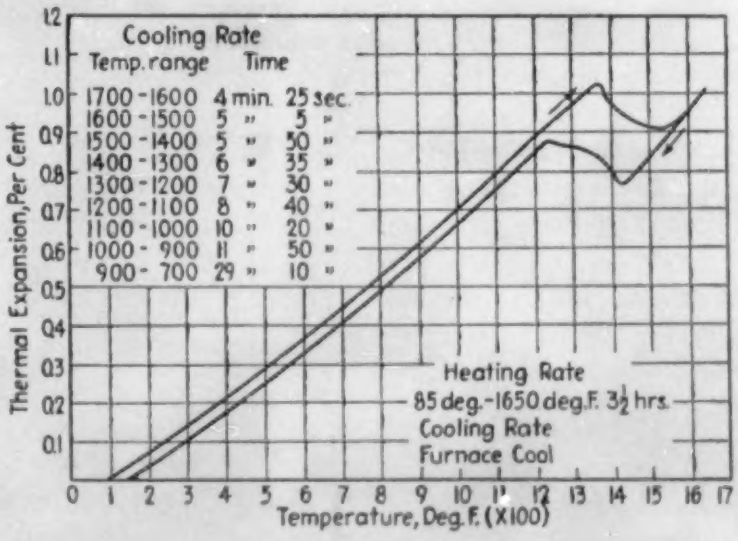

Cooling Rate
Temp. range Time
1700 - 1600 4 min. 25 sec.
1600 - 1500 5 " 5 "
1500 - 1400 5 " 50 "
1400 - 1300 6 " 35 "
1300 - 1200 7 " 30 "
1200 - 1100 8 " 40 "
1100 - 1000 10 " 20 "
1000 - 900 11 " 50 "
900 - 700 29 " 10 "
Heating Rate
85 deg. - 1650 deg. F. 3½ hrs.
Cooling Rate
Furnace Cool
Thermal Expansion, Per Cent
Temperature, Deg. F. (X 100)

Fig. 5. Thermal expansion of cast carbon steel, heat 14604

Gold Beaters' Art

—A Pictorial Presentation

Struggling valiantly for survival in a mechanical civilization that threatens to engulf it completely, the ancient art of gold beating persists because no machinery yet devised can accomplish the desired result. The skill of the gold beater as he bounces his heavy hammer hour after hour, reducing a block of gold to fragile leaf of gossamer thinness, has so far proved more than a match for machine age experts who have tried in vain to equal the results the artisan gets by hand.

On church spires, synagogue domes, public buildings and commercial signs this precious metallic tissue, one 282,000 part of an inch in thickness, gleams undimmed as it survives the ravages of time and the elements. Through a strange process, virtually unchanged since the time of Homer and Pliny, one single ounce of pure gold is normally beaten into enough leaf to cover 100 or more sq. ft. In strips 1 in. wide, this single ounce of gold would extend more than 1,000 ft.

The story of the ancient art of the manufacture of gold leaf is told pictorially on the following pages.

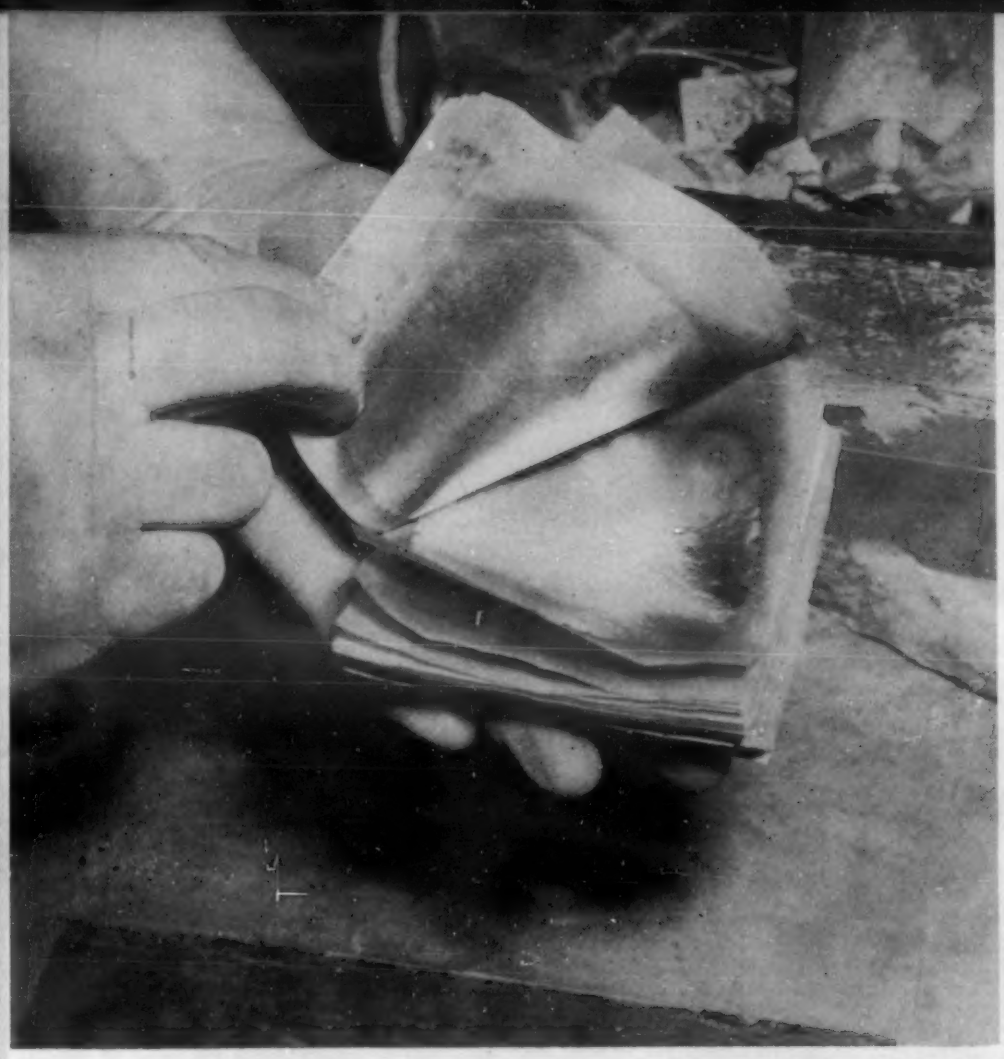
by EVERETT RUDLOFF
Oceanport, N. J.

1 *A block of pure gold weighing a little over 6 oz. is annealed by heating to a cherry red and plunging into dilute nitric acid to thoroughly clean the metal. When gold sells for $35 per oz., this block costs about $210. Some years ago, gold sold for $20.67 an oz., so that the increase has been 80 per cent.*

3 *A box full of gold ribbon, more than 30 ft. long, obtained from the original block of metal.*

2 *"Flatting" the gold into a ribbon. The rollers are gradually tightened as the lengthening ribbon is put through time after time until it is about 30 ft. long.*

4 *Squares of gold ribbon being placed in a "cutch," a package of alternated vellum and gold, wrapped in parchment paper. The ribbon is cut into 11 or 12 3-ft. lengths, called "cushions," from which 220 pieces of gold are cut and then beaten.*



5 *After 20 mins. of beating, the gold in the cutch looks like this. It must be beaten another 10 mins.*

6 *The pieces of gold, after quartering, are put into the package called a "shoder."*

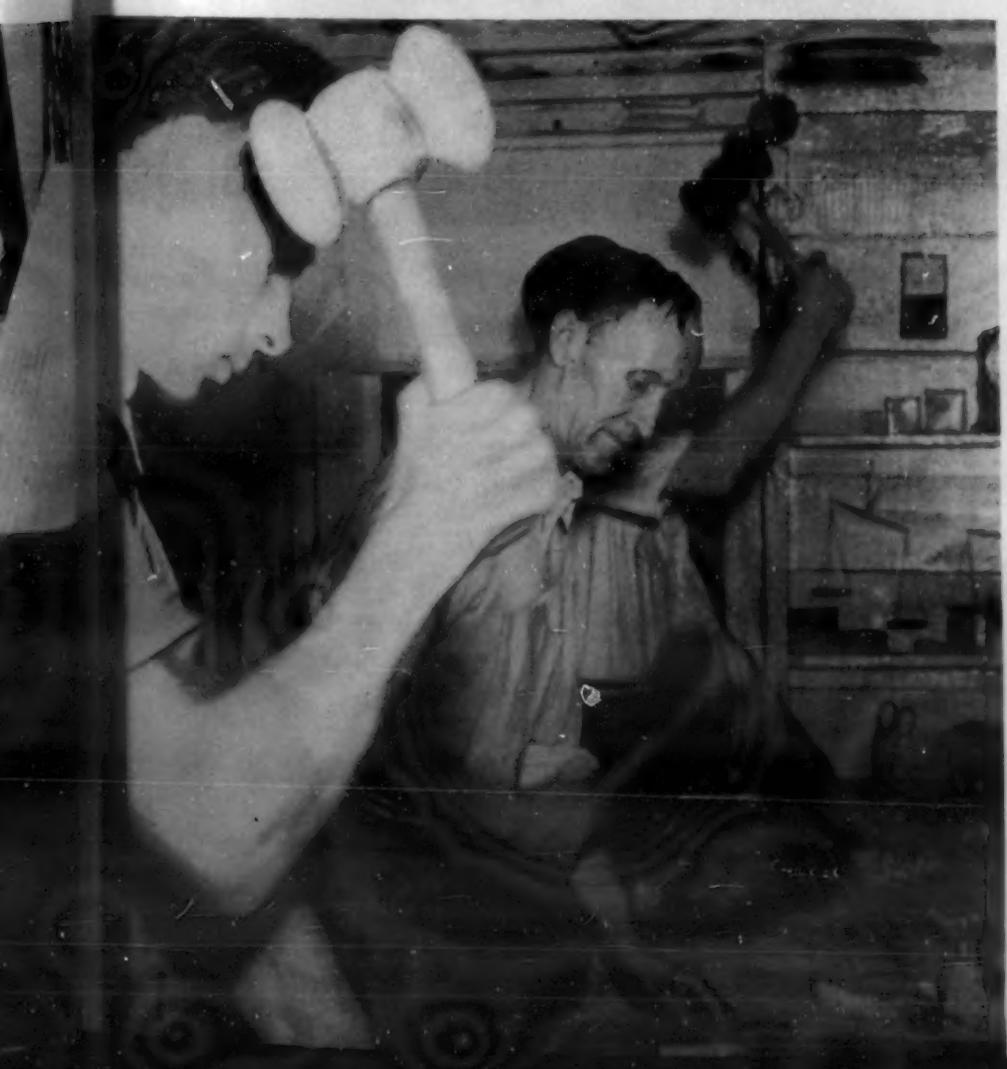
9 *Pieces of gold from the shoder are now alternated with molds and made into a parchment covered package, which is pounded for 4 hrs. with a 9-lb. hammer, after which the gold leaf covers the entire mold. The package rests on a granite block, which in turn rests on the end of a timber buried 5 ft. in the ground. This gives the proper "bounce" to the hammer.*

10 *The leaves are quartered and each quarter is now placed in a new package, alternated with molds, and the package beaten another 4 hrs. It takes 10 hrs. of beating from the ribbon to the finished leaf.*

7 *Gold beaters' skins have to be "conditioned" by subjecting them to trip-hammer blows for 40 mins. while the skins are sandwiched between hand-made tag paper obtainable only in England and encased in parchment. The pounding heats the package, makes the dirt adhere to the paper, and renders the skins clean. Skins are called "molds" by gold beaters.*

8 *"Briming the molds" with a rabbit's foot and briming powder made from a chalky material obtainable only from the Island of Wight and mixed wet with shaving soap. After the mixture is beaten with an egg beater to make it froth, it is dried and sieved twice to make the powder, used to prevent the gold leaf from sticking to the molds. A rabbit's foot must be used.*

11 *Here all are beating. They keep no general rhythm. Hammers are not lifted each time, but bounced, the beater's hand merely guiding it properly. The left hand turns package between each bounce. When they finish with the original block of gold, it will cover about 512 sq. ft. and would make a thin ribbon 1-in. wide and 1 1/5 miles long.*



12 *Placing book under weight. When 20 books have been cut, they are wrapped in a package which thus contains 500 sheets and sells for about $11. Some years ago, it sold for $9.80, an increase of only 13 per cent in sale price as against an increase in the cost of raw gold of 80 per cent. Many beaters have given up on this account.*

Handling Ammonia

BY L. H. BRANDT

E. I. du Pont de Nemours & Co., National Ammonia Div.

Engineers in the metal industries have been increasingly confronted with ammonia handling problems as the use of anhydrous ammonia for nitriding and for producing controlled atmospheres in heat treating has sharply expanded. To many—and particularly to a large number of engineers now using ammonia for the first time—helpful information on its storage, piping, vaporizing, distribution, etc., has been sorely needed. Such simple problems, for example, as determining when cylinders are empty and when leaks are present—doubly important now in view of the ammonia shortage—have perplexed scores of production men. In this article, outlining the correct engineering practice in the handling of ammonia, Mr. Brandt gives detailed answers to these and allied problems. —*The Editors*

As the War Program has expanded, there has naturally been an increased use of heat-treating equipment. Prominent in this development has been a tremendous increase in the use of ammonia in nitriding and as cracked ammonia for controlled atmospheres.

In the aircraft and other fields, the application of nitriding has been extended markedly and the use of cracked ammonia for heat treating armor plate piercing shells, alloy wire and so on, has also increased. And there are other uses of cracked ammonia. Over 200 companies are using the nitriding process and of course a good many are also using cracked ammonia for controlled atmospheres.

The proper methods for the handling of ammonia in the heat-treating industry are highly important and not always thoroughly understood by engineers. In order to clarify this situation, this article has been written.

Containers

Anhydrous ammonia in compressed and liquefied form is commercially available in cylinders and tank cars. The cylinders most widely used have a capacity of 100 or 150 lb. net. Most manufacturers carry a stock of cylinders containing 50 and 25 lbs. net, though transportation of large quantities in such small containers is uneconomical. For the convenience of experimenters, particularly in schools, the laboratory supply houses carry anhydrous ammonia repackaged into smaller containers. Anhydrous ammonia is also available in tank cars, most of which have a net capacity of 52,000 lbs.

The traditional type of ammonia cylinder is the tube as shown in Fig. 1b. This tube is a 7-ft. length of steel tubing fitted with concave heads. At one end there is a valve, which is completely protected by the recessed head. The valve is also fitted with a protecting cap to give added safety in transit. It is practically impossible to injure the valve of a tube type cylinder, even when the valve protecting cap is off.

In more recent years there has been a demand for an ammonia cylinder which can be stood upright on a scale during emptying. To meet this demand, many manufacturers can supply anhydrous ammonia in the "bottle" type cylinder (See Fig. 1a) whose external appearance is similar to that of chlorine, hydrogen, or oxygen cylinders. The data in Table I show the dimensions and weights of average tube and bottle type cylinders of various sizes; weights are with valve protecting caps removed.

Anhydrous ammonia tank cars consist of steel pressure vessels, insulated with cork, and covered with a sheet steel sheath. By virtue of the insulation, a greater poundage may be shipped in each car—the liquid is kept colder and, therefore, more dense. Duplicate fittings terminating in the dome permit the withdrawal of either liquid or gaseous ammonia. A spring-loaded relief valve, set to open at 250 lbs., is located at the center of the dome. In du Pont tank car equipment the two valves pointing to the ends of the car discharge liquid. The valves pointing crosswise discharge gas.

Table I.—Dimensions and Weights of Ammonia Cylinder Types.

Nominal Ammonia Capacity	*150 lbs.*	*100 lbs.*	*50 lbs.*
Tube type tare	235 lbs.	175 lbs.	105 lbs.
Bottle type tare	195 lbs.	135 lbs.	—
Tube type length	7 ft.	7 ft.	46 in.
Bottle type length	54 in.	54 in.	—
Tube type diameter	12 in.	10 in.	10 in.
Bottle type diameter	14 in.	12 in.	—
Capacity—cu. ft	4.8	3.2	1.6

for Metal Treatment

Cylinder Emptying

Both tube and bottle type cylinders in the service of E. I. du Pont de Nemours & Co., National Ammonia Div., are provided with dipper pipes, as shown in Fig. 1, so they will discharge either liquid or gas, depending on the position of the dipper pipe. When charging ammonia into refrigerating systems or into vaporizing equipment the cylinder should be placed as shown in Fig. 4. The dipper pipe will be pointing down. The cylinder should be tilted so that the valve end is 2 in. lower than the butt end. In this position a cylinder will discharge its contents against a back pressure of 25 lb. in less than 10 min. when the cylinder valve is wide open and there are no unusual restrictions in the line. Liquid ammonia may be withdrawn from either a tube or a bottle type cylinder when placed horizontally.

When drawing ammonia as a gas, cylinders may be stood upright (as shown in Fig. 2), or horizontally (as shown in Fig. 3). Bottle type cylinders are designed for vertical discharge. Tube type cylinders are designed to discharge ammonia from a horizontal position.

Heat Transfer in Ammonia Vaporization

The data in Table II show the heat required to vaporize 1 lb. of liquid ammonia without superheat. As the sensible heat present in the liquid and the enclosing cylinder is not great enough to effect rapid vaporization, calculations should be based on the assumption that practically all heat required in the vaporization of ammonia must be

Table II—Pressure, density of liquid, and latent heat of vaporization of liquid ammonia:

Temp. Deg. F.	*Gage pressure,—Lbs. per sq. in.*	*Liquid density,—Lbs. per cu. ft.*	*Latent heat of vaporization — B.T.U.'s per lb.*
-28	0.0	42.4	589.3
0	15.7	41.3	568.9
30	45.0	40.0	544.8
40	58.6	39.5	536.2
50	74.5	39.0	527.3
60	92.9	38.5	517.1
70	114.1	38.0	508.6
80	138.3	37.5	498.7
90	165.9	37.0	488.5
100	197.2	36.4	477.8
125	293.1	35.0	448.9

Fig. 1a. Bottle type of ammonia cylinder.

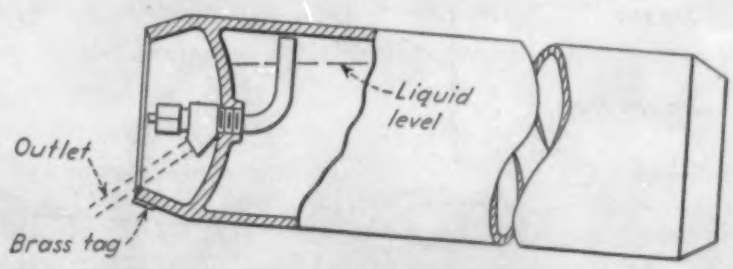


Fig. 1b. Tube type of ammonia cylinder.

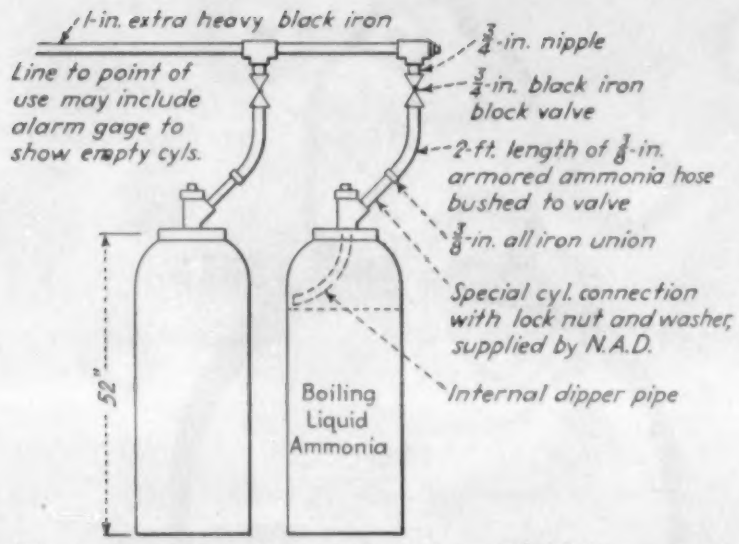

1-in. extra heavy black iron
Line to point of use may include alarm gage to show empty cyls.
¾-in. nipple
¾-in. black iron block valve
2-ft. length of ⅜-in. armored ammonia hose bushed to valve
⅜-in. all iron union
Special cyl. connection with lock nut and washer, supplied by N.A.D.
Internal dipper pipe
52"
Boiling Liquid Ammonia

Fig. 2. Layout (not to scale) of manifold for removing ammonia gas from battery of cylinders. One 150-lb. cylinder will discharge about 1 lb. of gas per hr. at 70 deg. F.

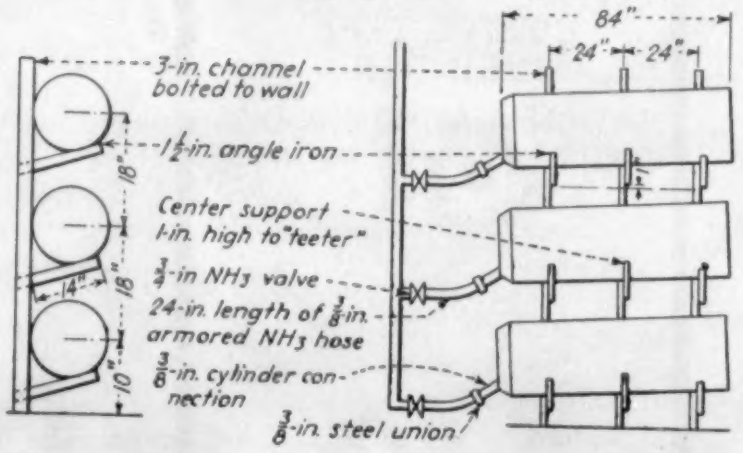


Fig. 3. Recommended layout for drawing gas from horizontally placed tube type cylinders.

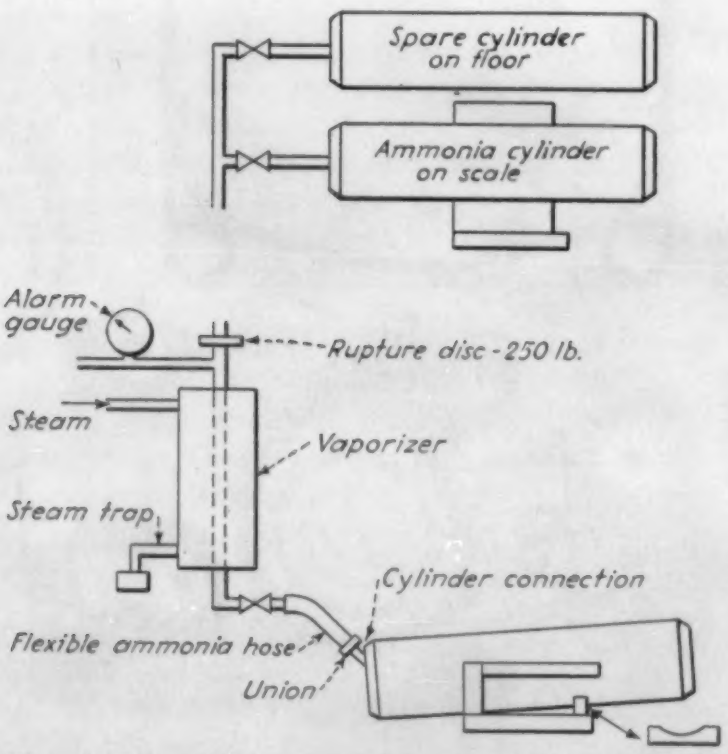


Fig. 4. Layout for ammonia vaporization system—one cylinder discharging liquid, the other as a spare.

taken from the atmosphere through the cylinder walls. From the practical angle, the area through which heat is transferred is only that area which is wet on the inside with liquid ammonia. A full cylinder will initially discharge its contents rapidly. A cylinder containing under 5 lb. of ammonia will discharge this remnant very slowly on account of the restricted area for heat transfer.

When drawing ammonia as a gas from a vertical cylinder it is evident that the last few pounds concentrated at the bottom will draw heat through only a small area. If the same ammonia poundage were being withdrawn from a horizontally placed cylinder, the area for heat transfer would be infinitely greater as the liquid is spread out over the entire length of the cylinder.

When laying out a battery of cylinders to discharge a known quantity of ammonia gas, sufficient cylinders should be connected in parallel to permit vaporization to complete dryness without frosting. Experience has shown that one bottle type cylinder vertically placed will discharge at a rate of 1 lb. of ammonia per hr. to complete dryness. The same rate of flow can be assumed for a vertical tube type cylinder.

A horizontal bottle type cylinder of either 100 or 150-lb. size will discharge about 1½ lb. of gas per hr. to complete dryness. A horizontal 100-lb. tube type cylinder will discharge 1½ lb. of gas per hr. to complete dryness. A horizontal 150-lb. tube type cylinder will discharge about 2 lb. per hr. to complete dryness.

Gas from Vertical Bottles and Tubes

Fig. 2 shows the recommended layout of a manifold withdrawing ammonia as a gas from one or more vertical bottle type cylinders. Where flows must not be interrupted, it is customary to provide connections for twice as many cylinders as are discharging at any one instant. The added cylinders are regarded as spares, which are thrown on the line when the original set runs dry.

Ammonia leaving a cylinder first goes through a special cylinder connection of ⅜-in. iron pipe size provided with a special lock-nut and washer. These fittings can be obtained from the E. I. du Pont de Nemours & Co., National Ammonia Division. Immediately following this connection is a union, followed by a suitable length of flexible armored ammonia hose, then a valve, which in turn connects to the manifold.

In a layout of this kind a pressure gage is usually located on the manifold. When the proper rate of flow is maintained this pressure will roughly correspond to the vapor pressure of ammonia at atmospheric temperature, as shown in Table II. If the cylinders are in a cool room there will

be a noticeable drop. When an insufficient number of cylinders are discharging gas, with resultant loss of pressure, there may be sweating and eventual frosting.

The pressure in a manifold drawing from several cylinders should remain above 100 lb. gage until the cylinders are practically empty. When approaching dryness there will be increased refrigeration, with attendant pressure drop. It is customary to assume cylinders are empty when the pressure drops to 40 lbs. Valves along the manifold should then be closed on the discharging cylinders and corresponding valves opened on the spares. Cylinder valves on the spares should then be opened and cylinder valves on the empty cylinders closed. Unions should be cracked on the empties and, after the pressure has bled off, the empties should be immediately removed and replaced by full cylinders. Empty cylinders should be so marked with chalk as it is difficult to tell an empty from a full cylinder on account of the great tare weight.

The drawing of gas from vertical tube type cylinders is not recommended as the tube will not stand upright without support. Where local conditions dictate the use of tube type cylinders in a vertical position, they should be chained or clamped near the top to a wall or other suitable support. A permanent balcony about 3 ft. from the ground is recommended to permit ready access to the cylinder and manifold valves.

Horizontal Tubes and Bottles

Fig. 3 shows the recommended layout for drawing gas from horizontally placed tube type cylinders. While cylinders can be placed on the floor, space is conserved by suspending them in a rack, as shown. The piping required is identical to that described above. The internal dipper pipe will point up and the external connections will point down, as shown. The cylinders should be either placed level or preferably with the valve end about 1 in. higher than the butt end.

The number of cylinders on the manifold should be double the number discharging at any one time. To determine when cylinders are empty the operator can depend on a pressure gage, as described above, or the cylinder rack can be constructed to permit "teetering."

If cylinders are supported at three equidistant points, with the center support 1 in. higher, an experienced operator can judge when a cylinder is almost empty. The liquid in a full cylinder will run to the low end and, therefore, the cylinder will not teeter. When a cylinder is almost empty it can be teetered by lifting the low end. An experienced operator can judge from the "feel" of the cylinder how much ammonia remains behind. When using an arrangement of this kind, a 4-ft. length of flexible hose is desirable as a short length will obscure the "feel."

Gas can be removed from bottle type cylinders by placing them in the same kind of rack as described above. On account of their unsymmetrical design and shorter length, it is more difficult to teeter bottle type cylinders.

Heating Cylinders to Promote Vaporization

Liquid anhydrous ammonia expands very rapidly on heating. Under the regulations of the Interstate Commerce Commission a cylinder may be filled to 85 per cent by volume (54% of its water weight capacity) at 70 deg. F. If this ammonia is heated to 130 deg. F. there will be sufficient expansion to render the cylinder 100 per cent full. Any further heating will subject the cylinder to hydrostatic pressure and may cause rupture.

It sometimes happens that ammonia users encounter abnormal conditions which appear to dictate in favor of applying heat to cylinders. If and when such a condition is encountered the ammonia users should consult with the ammonia manufacturer.

During the summer months when cylinders may be subjected to the sun's rays it sometimes happens that the liquid expands sufficiently that a vertical bottle type cylinder will initially discharge a few pounds of liquid. What has happened in this case is that the level of liquid, due to expansion, has risen above the lower end of the dipper pipe and liquid will naturally discharge until the level drops lower than the pipe. The amount of liquid discharged will usually be no more than a few pounds, therefore this phenomenon is seldom more than a temporary annoyance. The best way to control the situation is to keep the cylinders in the shade. A high pressure trap could be placed in the line where liquid ammonia could accumulate and subsequently boil off.

Gas lines should be so laid as to slant back towards the cylinder so that any slugs of liquid will not be blown into flow meters and pressure reducers. Experience has shown that an occasional slug of liquid will do little damage other than carry accumulated rust into a reducer.

Drawing Ammonia Gas from Tank Cars

When designing systems for the storage of tank car ammonia, it is wise to consult with the ammonia manufacturer so that the layout fits into the requirements of the user. When the storage tank is housed under a roof and the building has louvered sides, the pressure of the system will drop with atmospheric temperature. During a prolonged cold spell the pressure developed in such a system may be too low to operate certain heat-treating units.

The recommended procedure is to protect the tank against extremely cold weather by building solid sides all the way to the ground. Adequate ventilation may be effected by roof ventilators, doors and removable side panels. Provision should be made for maintaining at least a 50 deg. F. temperature throughout the winter.

Where less than 200,000 lbs. of ammonia is drawn annually from a single 13,000-gal. tank it will usually be simpler to draw the gas as such from the tank and provide for artificial heating in winter only. For larger consumptions it is better to draw ammonia from the storage tank as a liquid and vaporize it in a steam or electrically heated unit which will be described later on in this article.

Fig. 5 diagrammatically represents a tank car storage unit with a car connected as during unloading operations. A line to carry gas to the point of final consumption would tap off from the gas line which terminates in the top of the tank. A line to draw liquid would tap off from a line which extends at the bottom. The compressor is used only when unloading the tank car—the principle of unloading is to create a gas pressure in the tank car sufficient to blow the liquid out through the dipper pipe and thence to the storage tank.

Vaporization Outside the Original Container

When the rate of ammonia flow is such that more than four cylinders have to be connected in parallel to obtain the desired amount of gas, it is usually more practical to draw liquid from one cylinder at a time into a steam or electrically heated vaporizer. Fig. 4 illustrates the recommended layout. Ammonia is drawn from one cylinder at a time while that cylinder is on a scale. As the flows are relatively rapid and as it is frequently necessary to prevent flow interruptions, a scale is preferable to an alarm gage. With a scale the operator can accurately predict how much longer he can operate on the current cylinder.

A spare full cylinder should be on the floor, ready for use. When one cylinder is dry, the manifold valve is closed and the corresponding manifold valve on the spare cylinder opened. Immediately, the cylinder valve on the spare is opened and the cylinder valve on the empty closed. The spare can then be lifted to the scale while a fresh cylinder is placed beside it, ready for use.

Empty cylinders should be so labeled with chalk immediately as they may otherwise become mixed with full cylinders.

When using a steam-jacketed pipe, as shown, the only automatic control is the steam trap. As long the jacket is kept hot, ammonia will not flood through the vaporizer. Hot ammonia in the vaporizer will exert a back pressure, preventing the liquid level from rising to a point where the ammonia is hotter in the vaporizer than in the cylinder.

Table III.—Suggested vaporizer sizes in relation to maximum ammonia output.

Pounds ammonia per hr.	*Nominal size of internal pipe, in.*	*Lenth of steam Jacket, ft.*
10	1	1.4
25	2	2
50	2	4
75	3	3
100	3	3.5
150	4	4.5
200	5	4.6
250	6	4.8

When calculating the size of a vaporizer it is safe to assume the exchange of 250 B.t.u.'s per hr., per deg. F., per sq. ft. of transfer surface. From the practical angle, the principal problem is to prevent a vaporizer from surging. With this in mind, calculations are based on operation only one-third full on small installations and half full on large installations. If surging is anticipated it is always wise to tilt the vaporizer at a 45-deg. angle, which increases the surface area through which vaporization takes place.

The data in Table III suggest vaporizer sizes, as compared with maximum output.

A rupture disc should be located either on the top of the vaporizer or on the line immediately following the vaporizer. No valve should be between the rupture disc and the vaporizer. The rupture disc should be set to open at 250 lbs. The internal pipe, subject to ammonia pressure, should be extra heavy steel. The vaporizer can be of welded construction.

Waste steam is the customary source of heat. Where a large quantity of hot water is available, it can be used, though provision must be made to insure an adequate supply.

Certain heat-treating equipment (ammonia dissociators) drawing ammonia at rates requiring a vaporizer will be so equipped. Part of the heat required for vaporization will be picked up from hot "cracked" gases. The remainder is supplied by an electric belt around the vaporizer. Where vaporizers drawing sensible heat from effluent gases are supplied with heat-treating equipment, an auxiliary heat belt is usually supplied as otherwise during periods of intermittent flow, the exchanger may flood.

When considering the heating of tank car ammonia storage tanks, a question frequently arises about the wisdom of installing steam coils inside the tank. For two reasons internal heating coils are definitely not recommended. In the first place, if too much heat is applied to a full tank excessive pressures may be built up and the rupture disc broken. The escape of large quantities of ammonia

may be a source of extreme annoyance during the night shift when no one is on hand to repair the damage. If such a steam coil leaks, it is extremely difficult to repair the leak and water introduced into the ammonia may render it useless.

Gas Lines

When laying out long pipe lines to carry ammonia gas, cold spots should be avoided. Trouble has been encountered frequently where lines have passed open windows, as cooling may be sufficient to cause partial condensation. To prevent such condensed slugs from finding their way to heat-treating equipment, the line should be slanted so that any slugs will drain back towards the cylinder or vaporizer. No definite rule can be given for the drop per 100 ft., which will vary with the size of pipe employed and the severity of anticipated temperature drop.

When tapping off the line to heat-treating units, the line leaving the manifold should go up rather than down so that slugs will remain in the feed line.

When lines run out of doors for any distance it is wise to insulate such portions to reduce temperature drop. It is sometimes desirable to reduce the tendency towards recondensation by locating a pressure reducing valve on the cylinder end of any long line. If the pressure is reduced to 40 lb. per sq. in., no recondensation will take place until the temperature of the gas falls below the recondensing temperature, which in this case would be 25 deg. F.

Determination of Empty Cylinders

The only certain method for determining when cylinders are empty is to place them on a scale. In the case of tank car storage equipment, gage glasses will be provided which give a visual means of checking.

When ammonia is drawn as a gas from several cylinders at a time the teetering operation explained in the foregoing text is frequently used. Care must be taken that all cylinders are teetered as the upper cylinder of any bank will empty faster. As heat rises, the temperature of the upper cylinder on any bank will be higher than lower cylinders, therefore, upper cylinders will discharge faster. This fact militates against drawing ammonia as a *liquid* from several cylinders at a time because the warmer cylinder will discharge more quickly and in some cases the upper (warmer) cylinder of a set will discharge into a lower cylinder. Cases are on record where careless operators have teetered only the upper cylinder. Finding this cylinder empty they have assumed all cylinders were empty while the fact was that the bottom cylinder has been entirely full. Such a cylinder full of cold ammonia,

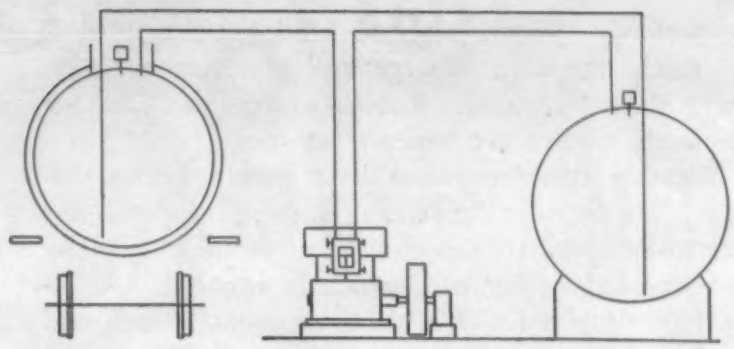


Fig. 5. A tank car storage unit with a car connected during unloading operations.

if taken off the line with the valve closed, may later warm up and the expanding liquid can rupture the cylinder. This has happened. Therefore, we recommend against drawing liquid from more than one cylinder at a time.

Where gas is being drawn from several cylinders simultaneously, the pressure gage on a common manifold will indicate complete emptying by quickly dropping from a high operating pressure almost to zero. Cylinders should be shut off and regarded as empties when this drop takes place. It is always wise to weigh cylinders to check that they are completely empty.

Where ammonia is being drawn from vertical cylinders at a high rate of speed, operators can watch the frost line drop. That part of the cylinder wet with liquid on the inside will frequently be covered with either sweat or frost. When the frost line recedes to the bottom of the cylinder, it is a safe assumption that the cylinder is empty.

Auxiliary Equipment

Special ammonia cylinder connections can be obtained from E. I. du Pont de Nemours & Co., National Ammonia Division. These are supplied with a rubber washer and a lock-nut, which give a tight connection at the cylinder outlet without the use of pipe cement.

Unions on the cylinder charging line will give better service if they are all iron. Ammonia will slowly attack brass seats. Reasonably good service can be anticipated with brass seats as in actual practice the mechanical wear on the brass seat will cause leakage before ammonia attacks it.

Valves should be of all iron construction. Heavy ammonia valves are recommended where complete tightness is required and where the valve will be frequently opened and closed. The so-called block valves give good service. They should be of at least 3/4-in. size. Black iron is satisfactory.

Piping should be of extra heavy steel or, for handling low pressure ammonia, standard black iron. Ammonia will attack galvanizing. Long lines should

be welded. Where screwed fittings are employed, a freshly prepared litharge and glycerine pipe cement should be used. Rubber gaskets designed for ammonia service are superior to lead.

Flexible cylinder connections should extend between the cylinder connection and the manifold line valve. Experience leads us to prefer a specially compounded rubber base which is armored. A ⅜-in. hose provided with male connections at each end is the most convenient. One end will fit into the union at the cylinder connection and the other can be bushed to a ¾-in. manifold valve.

Rupture discs are preferable to spring-loaded relief valves. Ammonia is hard to hold in a spring-loaded valve and on account of corrosion a spring-loaded valve may not operate. If a spring-loaded valve is used it should be of all-iron construction and designed for use with ammonia.

Pressure reducing valves should be of all iron construction and designed for use with ammonia. Brass reducers which are satisfactory for compressed air will not give good service with ammonia.

Gages should be all steel. Avoid compressed air gages containing a brass Bourdon tube.

Flow meters should be designed for use with ammonia. Be sure a calibrated flow meter will give desired flows at the high side pressure available. Where flow meters are at the end of long lines, it may be desirable to locate a pressure reducer at the cylinder, in which event the meter must operate at a 40-lb. high side pressure. In the case of meters for use with nitriding furnaces a special calibration and large orifice may be necessary. Regular ammonia flow meters are usually designed to operate at 120 lb. high pressure and will not give full flows at lower pressures. Manufacturers can supply flow meters for low pressure operation, when so requested.

In many plants using ammonia for heat treating, there is a marked temperature drop during the night, which will be reflected in a corresponding ammonia pressure drop. This has necessitated vigilance on the part of operators to maintain a constant flow. This fluctuation in ammonia pressure on account of temperature drop can be minimized or completely done away with by connecting a pressure reducing valve between the cylinder and the flow meter. The cylinder discharge pressure may vary as much as 20 lb. A good pressure reducing valve should level out this drop so that the low side pressure on the flow meter will remain practically constant. This same pressure reducer will prevent any recondensation prior to the flow meter.

Testing for Leaks

Ammonia being alkaline can be detected by its characteristic reaction with certain "sensitive" papers.

In the heat-treating industry a more convenient method of determining leaks is by means of a burning sulphur taper. Sulphur dioxide released by the combustion of sulphur will react with ammonia, giving a heavy white smoke. As ammonia is not flammable, the use of a burning sulphur taper is safe for detecting pure ammonia leaks. A burning sulphur taper should not be used to find leaks in cracked ammonia lines, especially where the cracked ammonia may be mixed with air, as on the outlet of furnaces during flushing operations.

Where ammonia consumers encounter unusual problems, especially where safety is concerned, it is advisable to seek the assistance of ammonia manufacturers. E. I. du Pont de Nemours & Co., National Ammonia Div., for example, maintains a technical staff for the purpose of supplying data on safe ammonia handling practices.

A COUPLE OF CHUCKLES

Saving Tin Plate

To the Editor: I enclose for your consideration a clipping from our local paper of last night.

Brookline, Mass., March 28 (INS)—When Mrs. Martha Peabody Keith started out to do something for national defense she took inventory of her assets and found she had one hairpin, one husband who manufactures bottle caps, two married daughters.

Eliminating her married daughters, Mrs. Peabody set about combining her hairpin and her husband into a war product.

She succeeded so well that before long your bottles and jars will come equipped with paper caps held in place by a hairpinish looking gadget.

And the saving of tin plate, now a much sought after commodity for war purposes, will run to some 98,000,000,000 lbs.

Mrs. Keith holds a patent on her invention. It will be made of black iron, a cheap form of metal.

Any scheme which will make a saving of 98,000,000,000 lbs. (48,000,000 net tons) of tin plate when total production is of the order of 2,500,000 tons, should certainly be brought to the attention either of the Materials Section of the WPB, or of your "Chuckles" editor. I leave you to decide to which it should be referred.

G. A. Roush

Bethlehem, Pa.

Sources of Scrap

One of our Editorial Advisory Board suggests that the brass spittoons in Army offices and posts, Navy offices and yards, as well as the rubber mats on which they rest be collected for reworking into cartridge brass and tires. Why not use the waste basket for the duration?

It may also be recalled that there are 4,500 tons of cast iron in the Capitol dome. Are there no circus tents available? Wasn't it the Little Flower who wanted the aluminum cap of the Washington Monument included in the pots and pans collection of unhallowed memory?

—H. W. G.

Practical Pointers for War Manufacturers

Designing to Save Scarce Non-ferrous Metals

by CARTER S. COLE

Specifications Branch, Bureau of Industrial Conservation,
War Production Board
Washington

The time when we as Americans and as engineers could pick a material just because we liked it has passed. There is only one criterion by which we should judge our material-choices today—"If it works, we will use it." Restrictions on the use of various materials, aluminum, copper, tin, etc., have brought home to us forcibly that we do not have all of these metals that we can use. Our job today is very definitely to make what we have do the most effective work that it can to further our War effort.

Combat material comes first—everything else is secondary. Even in the combat material there is no reason for using material that is better than it needs to be. Indeed, we might add an Eleventh Commandment: "Thou shalt not use scarce or strategic material when thou needst not do so."

The material that will actually be used in any given instance is the designer's responsibility. The specification writer can only give him the tools with which he works. Those that have heretofore been available have not always been truly adequate for all phases of conservation. To deal with this problem there has recently been completed a careful review of the copper-base alloy castings field by A.S.T.M., the Federal Specifications Committee, and more recently by the S.A.E. This work was initiated at the request of the Specifications Branch of the Bureau of Industrial Conservation of the War Production Board and the development work was carried through to a successful conclusion by Subcommittee X of A.S.T.M. Committee B-5, under the guidance of Dr. G. H. Clamer as Chairman of the Subcommittee and Major C. H. Greenall as Chairman of the main Committee.

All the emergency alternates set up by A.S.T.M. have been written with two primary objects in view —first, to cut down the tin content, and secondly, to permit the greater use of secondary material. The emergency alternates to the Federal specifications also work towards exactly the same end and S.A.E. at a special meeting of their Non-ferrous Metals Division in Detroit on April 22 adopted the A.S.T.M. emergency alternates for the tin bronzes.

An illustration as to how the designer can make use of these emergency alternates can be taken directly from the emergency alternate of the Federal QQ-B-691a specification. This calls attention to four types of substitutions that may be made:

(1) Substitutions that conserve tin—a change to straight copper-zinc or to a copper-silicon alloy.

(2) Substitutions that conserve both tin and copper—changing to yellow or Naval brass instead of a tin bronze.

(3) Substitutions that conserve all non-ferrous elements—changing to gray cast iron, malleable iron, or cast steel, where this is possible.

(4) When a tin bronze is absolutely necessary for the purpose in hand, to use the alloy with the lowest possible copper and tin content, and to pick an emergency alternate grade that permits the use of secondary metal whenever it is possible to do so.

These are the same thoughts that should be borne in mind by any designing engineer when he examines the emergency alternate specifications to see what substitutions he can make that will result in true conservation. The new tools that he has been given for this purpose are shown in the tables accompanying this article, which tabulate the recommended substitutions and compare the compositions of the standard alloys and the emergency alternates.

Please turn to the next page for the Alternate-Material Tables

Reference Table of

ALTERNATES AND SUBSTITUTES

SECTION 3—BRASSES AND BRONZES

Compiled by Carter S. Cole,
War Production Board

On the preceding page a general description is given of emergency alternates for brasses and bronzes recently set up by A. S. T. M., together with some practical suggestions for utilizing them. In the tables below are presented the compositions of the "standard" alloys and of the substitutes specifically recommended for each, together with their mechanical properties. —The Editors.

A.S.T.M. Specification B 143

PRESENT ALLOY	SUBSTITUTE	COMMENTS
G 1 A (88-10-0-2) } G 1 B (88-8-0-4) }	{ 2 A (88-6-1.5-4.5) 2 X (87-8-1-4) 2 Y (88-8-0-4)	The basis of these recommendations is to reduce the "G" metal composition from 88-10-2 to 88-8-4 (or to "M" metal for pressure parts—that is alloy 2A). To further the possibility of using secondary metal, the impurity limits, particularly lead, are raised slightly.
M 2 A (88-6-1.5-4.5)	None	
M 2 B (87-10-1-2)	2 X (87-8-1-4)	

	1 A	1 B	2 A	2 B	2 X	2 Y
Cu	86-89	86-89	86-89	86-89	86-89	86-89
Sn	9.0-11	7.5-9	5.5-6.5	9.0-11	7.5-9	7.5-11
Pb (max.)	.30	.30	1-2	.75-1.5	1.00	.60
Zn	1-3	3-5	2.5-5	1-3	3-5	1-5
Ni (max.)	1.00	1.00	1.00	1.00	1.00	1.00
Fe (max.)	.15	.15	.20	.20	.25	.25
P (max.)	.05	.05	.03	.05	.05	.02
Other (max.)	.25	.25	.35	.35	.35	....
Tensile Strength	40,000	40,000	34,000	36,000	36,000	40,000
Yield Strength	18,000	18,000	16,000	16,000	16,000	18,000
Elongation	20	20	20	15	18	20

"G" 1 A equals QQ-B-691a Grade 5. "G" 2 X equals QQ-B-691a Grade 6, 6 X and 5 E A. "M" 2 A equals QQ-B-691a Grade 1.

A.S.T.M. Specification B 144

PRESENT ALLOY	SUBSTITUTE	COMMENTS
B 66 (Hard Bronze)	3 X (80-7-10-3)	Included in this table are the recommendations for changes in B 66 alloys that have been made to the A.A.R. and on which that body has not yet officially acted. It will be noted in comparing the compositions that here again, the substitutions called for lower tin and slightly greater use of zinc and a slight opening of the impurity limits.
B 66 (Phosphor Bronze)	3 Y (84-8-8-0)	
3 A (80-10-10-0)	3 B or 3 X or 3 Y	
3 B (83-7-7-3)	None	
3 C (85-5-9-1)	None	

	Hard Bronze	3 X	3 A	3 B	3 Y	Phosphor Bronze
Cu	remainder	77-81	77-81	81-85	82-85	remainder
Sn	7-10	6-7.5	9-11	6.25-7.5	7-9	9-11
Pb	10-15	8-11	8-11	6-8	7-9	9-11
Zn (max.)	1.25	2-4	.75	2-4	.75	.5
Ni (max.)	....	.5	.5	.5	1.00	....
Fe (max.)	....	.20	.15	.20	.15	....
Sb (max.)	....	.75	.55	.25	....	....
P (max.)	....	.05	.05	.03	.2-.5	.2-.4
Other (max.)	.75	.35	.35	.35	.50	1.00
Tensile Strength	....	25,000	25,000	30,000	25,000	....
Yield Strength	....	12,000	12,000	14,000	12,000	....
Elongation	....	8	8	12	8	....

3 Y equals QQ-B-691a Grade 8.

A.S.T.M. Specification B 144

PRESENT ALLOY	SUBSTITUTE	COMMENTS
B 66 (Medium Bronze)	3 Z (78-6-15-1)	Included in this table are the recommendations for changes in B 66 alloys that have been made to the A.A.R. and on which that body has not yet officially acted. It will be noted in comparing the compositions that here again, the substitutions called for lower tin and slightly greater use of zinc and a slight opening of the impurity limits.
3 D (78-7-15-0)	3 Z (78-6-15-1)	
B 66 (Soft Bronze)	3 W (70-5-25-0)	
3 E (70-5-25-0)	3 W (70-5-25-0)	

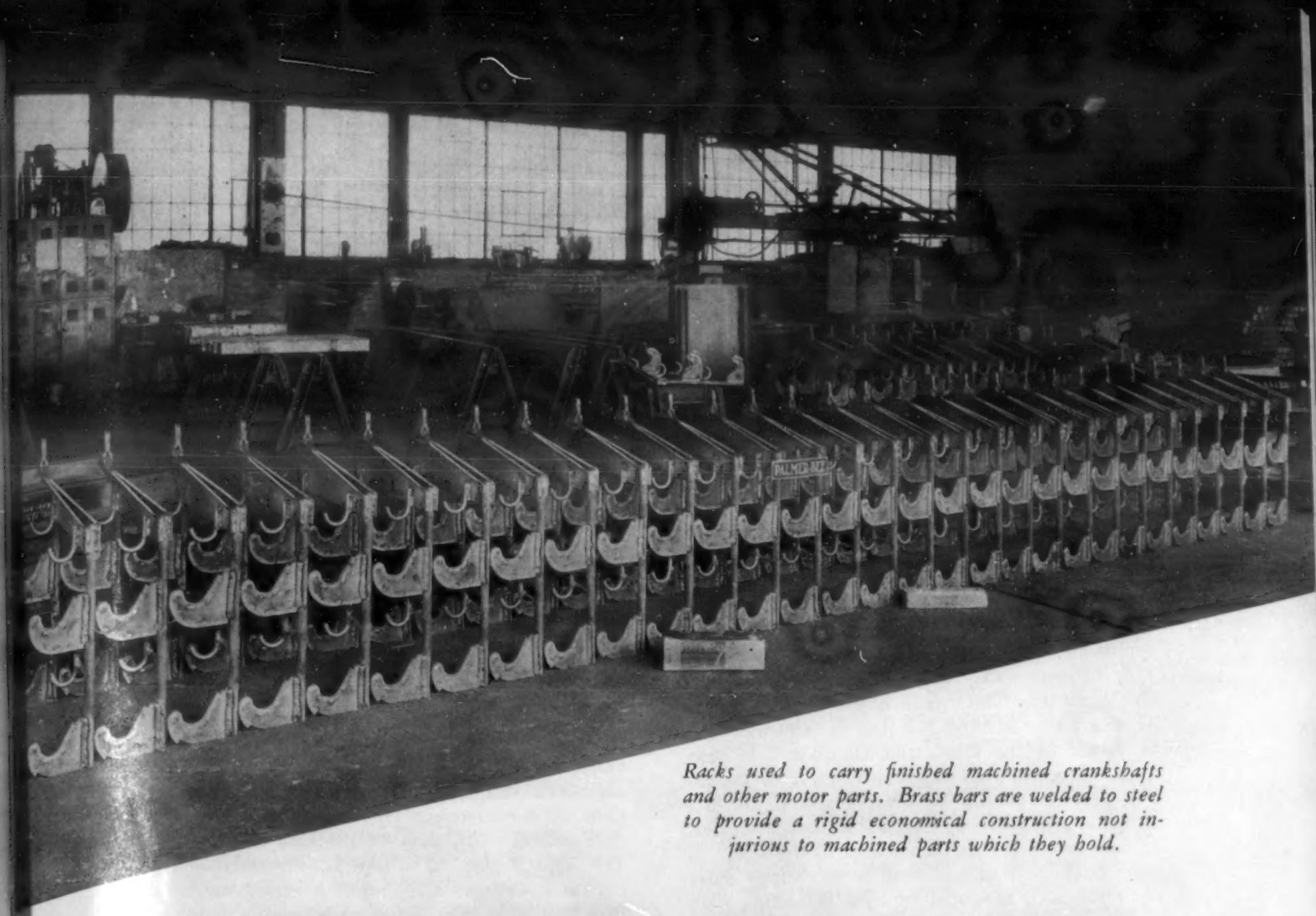
	Medium Bronze	3 D	3 Z	Soft Bronze	3 E	3 W
Cu	remainder	75-79	75-79	remainder	67-71	67-71
Sn	6-8	6.25-7.5	5.5-7	4-6	4.25-5.5	[illegible]
Pb	14-22	13-16	13-16	23-27	23-27	23-27
Zn (max.)	1.25	.75	1.25	.75	.50	.75
Ni (max.)	....	.75	.75	....	1.00	1.00
Fe (max.)	....	.15	.15	....	.15	.15
Sb (max.)	....	.75	.75	....	.75	.75
P (max.)	....	.08	.08	....	.05	.05
Other (max.)	.75	.35	.35	.75	.35	.35
Tensile Strength	....	25,000	25,000	....	21,000	21,000
Yield Strength	....	14,000	14,000	....	11,000	11,000
Elongation	....	10	10	....	7	7

A.S.T.M. Specification B 145

PRESENT ALLOY	SUBSTITUTE	COMMENTS
4 A (85-5-5-5)	5 X (81-3-7-9)	It will be noted that in this specification a new alloy, 5 X, has been established, having the same nominal composition as the old 5 A but with slightly higher physicals. It is proposed to adopt the requirements of 5 X in place of the present 5 A. In the meantime, the 5 X alloy can, of course, be used in place of either 4 A, 4 B, or 5 A with one exception —where salt or other extremely corrosive water is involved, it will probably still be necessary to retain composition 4 A. Alloy 5 X is already noted as the new Grade 11 added to the Federal specification.
4 B (83-4-6-7)	5 X (81-3-7-9)	
5 A (81-3-7-9)	5 X (81-3-7-9)	
5 B (76-3-6-15)	None	

	4 A	4 B	5 A	5 B	5 X
Cu	84-86	82-83.75	79-81.75	75-76.75	78-82
Sn	4.25-5.75	3.25-4.25	2.5-3.25	2.5-3.25	2.5-3.25
Pb	4.5-6	5.5-7	6.25-7.25	5.25-6.75	6-8
Zn	4-6	5.5-8	8-10	13-17	7-10
Ni (max.)	1.00	1.00	1.00	1.00	1.00
Fe (max.)	.30	.30	.40	.40	.40
P (max.)	.03	.03	.02	.02	.02
Other (max.)	.50	.50	.50	.50	.50
Tensile Strength	30,000	29,000	28,000	25,000	29,000
Yield Strength	14,000	12,000	12,000	12,000	13,000
Elongation	20	15	15	15	18

5 X equals QQ-B-691a Grade 11.



Racks used to carry finished machined crankshafts and other motor parts. Brass bars are welded to steel to provide a rigid economical construction not injurious to machined parts which they hold.

Arc Welding Dissimilar Metals

by A. F. DAVIS

Vice President, Lincoln Electric Co., Cleveland.

Engineers in the metal industries more and more often must reckon with combinations of different metals in the design and production of a single metal part or product. In many cases a combination of materials offers design advantages that a single metal as a conventional one-piece casting or forging might lack. This article shows that dissimilar metal combinations—whether as joined components or surfacings—can be readily welded with suitable technique, and tells how. —The Editors.

UNDER PRESENT CONDITIONS when every production set-up requires all the ingenuity within reach of production officials to get the work out, the question is bound to arise—"Is there any better way of doing it?"

If the question has to do with utilizing or fabricating combinations of different metals in the same product, perhaps there *is* a better method. The use of welding, for example, may provide a means for employing the duplex advantages of two metals in the product, with faster production and less waste to boot. Arc welding has been used with excellent results for joining one type of metal to one of a different type in several instances.

Typical combinations include: Brass-to-steel—cast-iron-to-steel — high-manganese-steel-to-low-carbon steel. Certain general conditions are to be considered in these cases. The bead joining the two metals will be of composite makeup, owing to the dilution or in-wash of one metal by the other. This hybrid bead must be carefully considered as to its physical characteristics relative to the base metals. The heat effect of welding also affects the results. A third metal, deposited as a transition bead, may be used, and its effects are to be considered.

Using Transition Beads

Brass-to-Steel:—Assume that it is required to join a brass bar to steel plate with a lap joint. A bronze electrode is used. First, deposit bronze beads on the steel. These beads are then joined to the brass by the same type of bronze electrode. (See illustration).

The electrode has a coating that shields the molten metal from the contaminating influence of the air and assists in the easy flow of the metal in the arc. The resulting deposit is homogeneous and of good tensile strength with the characteristics of true phosphor bronze.

Positive polarity should be used, *i.e.*, electrode positive, work negative, with the following values:

Size, in.	*Arc Voltage*	*Amperage*
1/8	22 to 26	50 to 125
5/32	24 to 28	70 to 170
3/16	24 to 28	90 to 220

For best results, the electrode should be held at approximately 90 deg. to the work.

Cast-Iron-to-Steel:—A suitable steel bead is placed on the cast iron. This may be of one or several layers. There are now in effect two steel surfaces which can be joined by the usual steel electrode. In some cases, where parts are not free to move or the cast iron is a bit difficult to weld, a special cast iron electrode with a steel base is used to deposit the bead on cast iron. This is then joined to the steel. In some cases the transition bead is an entirely different metal such as would be used in joining high-manganese steel to low-carbon steel.

High-Manganese-to-Low-Carbon-Steel:—Owing to the characteristics of manganese, a stainless steel electrode of the 18 and 8 type having columbium in either the core wire or coating, is used to deposit a bead on the manganese and this bead is in turn joined to the low-carbon steel by a stainless steel electrode. The stainless steel transition bead can also be joined to the low-carbon steel by a steel electrode.

These examples illustrate the use of transition or intermediate beads, and suggest that when two dissimilar metals are to be joined an electrode should be selected which may be easily and effectively deposited on one metal to form a surface that may then be joined readily to the other. Due regard for physical properties and heat effects upon these combinations of metals must be taken into account.

Numerous problems are readily solved by this method of using transition beads.

Surfacing by Welding

Although surfacing by welding was used mostly for salvaging worn equipment in the early days of welding, the process is recommended and economically employed in applying effective wearing surfaces to new equipment during manufacture or prior to use.

The application of surfacing by welding should be considered from the viewpoint of service life of the equipment. Any piece of equipment must perform satisfactorily and meet certain very definite load conditions. Service life, measured in performance and cost of that performance, must be adequate. This adequate performance may be obtained either by making the entire part of a given kind of metal, such as steel, or by using one metal as a support and another to receive the load.

Four definite reasons for the use of surfacing in the fabrication of various types of equipment are: (1), it improves service life; (2), it reduces overall cost; (3), it lessens operating cost; and (4), dimensions are maintained within fairly narrow limits when surfacing is used as compared to a single metal.

The service life of equipment involves the load conditions to which the parts are subjected. These loads may be classified as to rate of application of the loading such as uniform, impact, and vibrating. Other factors affecting service life include wearing conditions, such as abrasion or corrosion and conditions of temperature. Under impact loading, the time rate of application of the load is important. The impact effect of a slow-moving train on the rails as it traverses a cross-over is very much lower than that of a train traveling at high speed. In another instance, impact may be momentary as in the case of a shovel tooth striking a rock, or a cam operating in a machine.

In considering wear, abrasion is usually regarded as a grinding action as when operating in sand; or a sliding, rubbing, or rolling action as when one metal moves over another. Corrosion involves gas or atmospheric conditions as well as liquids and, in some cases, the action of solids on the material under consideration. Operating temperatures also affect service life.

Insofar as surfaces deposited by arc welding are concerned, another consideration is important. This is the condition of the surfacing metal immediately after it is deposited. The surface either possesses its complete characteristics as deposited, or it must receive some subsequent treatment. For example, one surface may be hard as deposited, while another may require peening to obtain the desired hardness; or, in another case, the surface may require heat treatment after deposition. Thus, surfaces may be classified under two groups, viz: (1), load conditions and (2), condition of the surface after deposit, the latter being a factor in considering load requirements.

Comparative Quality of Converter Cast Steel

An Extended Abstract

by C. E. Sims and F. B. Dahle

Supervising Metallurgist and Assistant Supervisor, respectively, Battelle Memorial Institute, Columbus, Ohio

The combination of heavily increased demand for steel castings in the war production program and the disconcerting idleness of a considerable part of our gray iron foundry facilities focuses attention on the possibility of employing existing cupolas in conjunction with side-blow converters to make steel castings. This possibility has been limited to some extent by the prejudice with which cast converter steel has been regarded in some quarters.

Information on the quality of converter cast steel as compared to that made by other processes is thus very much needed. Such information was originally presented in a paper by Sims and Dahle at the A.S.T.M. convention last month.

The extended abstract given herewith was prepared for us by John Howe Hall, consulting metallurgical engineer. —*The Editors*

THE ALL-OUT WAR EFFORT in which we are now engaged, demands the utmost use of all available and suitable agencies of production. An unprecedented demand for steel castings necessitates a greatly increased productive capacity. One method by which capacity may rapidly be expanded is the cupola-converter combination.

The possibilities of converter steel may have been overlooked because its use was prohibited by certain specifications. In the case of cast steel, there were no adequate technical data with which to make an impartial appraisal of the quality of converter steel as compared to cast steel made by other processes and proven by actual use to be suitable. The present paper supplies data by which the comparative quality of cast converter steel may be judged.

The electric furnace was introduced to the foundries of the United States in 1909, at a time when the converter was almost the only economical producing medium open to the small jobbing foundry. The converter reached peak production in 1918 at 180,000 tons, but by 1919 the electric furnace had passed it, and by 1930 converter output had fallen to 16,500 tons. Hamilton[1] has clearly shown that the conditions that led to the adoption of the electric furnace were mainly economic and not quality considerations. Now that side blow converter cast steel can be made to the same chemical composition as acid open-hearth or acid electric cast steel, the present question is, does it nevertheless differ essentially in mechanical properties? It seemed that an appraisal of these properties was in order. The present investigation was sponsored by the Whiting Corp. for the purpose of determining the facts, and contemplated as a follow-through study of means to correct any deficiencies that might be found. All of the steels used were from regularly produced commercial heats.

The specimens of cast steel used for testing were furnished by various commercial foundries, in the form of coupons cut from keel blocks of substantially identical design. The processes represented by the specimens include acid and basic open-hearth, acid and basic electric, side blow converter, and triplex (cupola-converter-acid electric). An effort was made to obtain at least two heats of each type from each contributing shop, and to have two shops represented by each process. Triplex heats were obtained from only one shop and only one basic electric steel was secured. The request was made that all of these steels represent the current standard practice in use at any particular shop, except converter heats 4 and C (see Table I), in which it was asked that titanium be used in addition to the regular deoxidizers, and converter heat D, in which an addition of 2 lbs. of aluminum per ton was requested.

As none of the open-hearth or electric steels were deoxidized with aluminum, two acid electric heats deoxidized with 2 lbs. of aluminum per ton were later especially requested from the shop that furnished heats 715 and 724; only one heat, 1163, was received in time for inclusion in the present paper.

Heat Treatment

All coupons were received in the as-cast condition, and all were heated to 1650 deg. F., held for 2 hrs.

Table I. Chemical Analyses of Grade "B" Cast Steels

Steel Number	Composition, Per Cent					Residual Metals, Per Cent					Special Deoxidizers Added to Ladle, Lbs. per Ton			
	C	Mn	Si	P	S	Cu	Cr	Ni	Mo	N	Al	Fe-Ti	Ca-Si	Ca-Si-Mn
Acid Open-Hearth Steels														
493	.21	.69	.42	.030	.035	.11	.05	.01	.006	.006	...	2	3	...
509	.24	.66	.47	.036	.035	.12	.04	.01	.006	.005	...	2	3	...
F-1	.33	.67	.36	.036	.036	.05	.02	.04	.060	.005	...	...	...	...
F-2	.30	.85	.37	.035	.033	.04	.02	.04	.051	.006	...	...	...	...
Basic Open-Hearth Steels														
9551	.27	.58	.46	.013	.025	.15	.14	.06	.016	.005	...	...	...	...
9567	.27	.68	.45	.019	.034	.10	.12	.05	.012	.005	...	...	...	...
O-1	.32	.72	.34	.017	.027	.12	.05	.15	.04	.004	...	...	...	...
O-2	.30	.77	.34	.016	.029	.12	.06	.17	.03	.004	...	...	...	...
Acid Electric Steels														
715	.27	.80	.45	.027	.034	.06	.05	.03	.013	.008	...	3	...	3
724	.26	.72	.39	.026	.036	.08	.03	.06	.009	.008	...	3	...	3
1009	.26	.68	.40	.034	.038	.11	.06	.18	.038	.010	...	4	...	1.5
1025	.24	.66	.39	.035	.040	.11	.06	.16	.034	.009	...	4	...	1.5
1163	.26	.68	.49	.036	.037	...	...	...	...	.009	2	...	...	...
Basic Electric Steels														
E-1	.34	.88	.28	.033	.035	.12	.19	.43	.06	.007	0.7	...	...	...
Converter-Acid Electric Steels (Triplex)														
H-30	.30	.73	.40	.029	.035	.36	.04	.08	.056	.011	2 *	...	2	...
H-34	.34	.78	.40	.033	.036	.39	.04	.06	.062	.011	2 *	...	2	...
H-38	.33	.58	.31	.023	.041	.38	.03	.08	.005	.012	2 *	...	2	...
H-42	.35	.73	.35	.059	.047	.43	.03	.10	.004	.010	2 *	...	2	...
Converter Steels														
1	.26	.77	.55	.034	.041	.19	.04	.09	.008	.008	2	...	...	...
2	.26	.66	.38	.032	.027	.09	.04	.06	.006	.009	2	...	...	...
3	.27	.65	.37	.038	.026	.09	.05	.06	.007	.009	2	...	...	...
4	.26	.50	.32	.033	.028	.14	.03	.05	.007	.009	2	2	...	...
A	.29	.50	.33	.040	.031	.09	.02	.085	.008	.006	1	...	...	...
B	.33	.85	.43	.043	.035	.09	.02	.072	.018	.008	1	...	...	...
C	.33	.64	.39	.049	.038	.10	.03	.079	.018	.007	1	1.7	...	...
D	.29	.73	.36	.044	.035	.09	.03	.077	.014	.007	2.25	...	...	...

* Aluminum added to electric furnace in these heats.

and cooled separately in still air. One set of tensile bars was machined and tested within 3 days of the normalizing treatment; the rest of the coupons were annealed at 750 deg. F. for 15 hrs. This treatment is known to eradicate hydrogen embrittlement without affecting the tensile strength of a normalized medium-carbon steel; aging at normal temperatures for a longer period will accomplish the same result. Any improvement in ductility produced by this low temperature anneal is regarded, therefore, as a qualitative evidence of hydrogen embrittlement in the normalized bars.

Composition of the Steels

The compositions are shown in Table I. It will be noted that all the heats come in the grade "B" classification; the chromium and nickel content of the basic electric furnace steel E-1, and the copper content of the triplex steels undoubtedly affect the properties of those heats. The basic open-hearth steels are the lowest in phosphorus, the converter steels as a class the highest. The triplex steels were given a ladle dephosphorizing treatment; in heat H-42, converter slag got into the ladle and made the dephosphorizing slag too acid to be effective.

The basic open-hearth also has a slight advantage in sulphur content; ladle desulphurizing treatments have put the converter on a par with acid electric and acid open-hearth in this respect.

Nitrogen contents were determined by the Cunningham distillation method. The accuracy of the reported results is not considered greater than plus or minus 0.002 per cent, but certain trends are apparent. The triplex steels have the highest nitrogen content, the straight converter steels and the acid electric steels are in the medium range, while the open-hearth steels are the lowest in nitrogen.

Microstructure

Microscopic examinations were made to determine the nature of the inclusions and the grain size, inasmuch as both are known to affect the mechanical properties. Except that the high sulphur steels had more sulphides than those low in sulphur, there was no notable difference in cleanliness.

The types of inclusions are shown in Fig. 1,

[Fig. 2 of the original paper] and are found to coincide closely with the deoxidation practice and particularly with the use of aluminum, as described by Sims and Dahle[3]. When no aluminum was used, regardless of whether or not calcium or titanium was used, the inclusions consisted of globular sulphides of the No. I type (Fig. 1, Fig. 2 in the original). Steels with this type are inclined to have good ductility.

When the additions of aluminum are too small to leave an appreciable excess, the silicates disappear and the sulphides assume the eutectic form of Type II (Fig. 1, Fig. 2 in the original). Such chain or film type sulphides, strung along the primary grain boundaries, act as zones of weakness and produce poor ductility, as described by Sims and Lillieqvist[4].

If enough aluminum is used to leave an appreciable excess, the sulphides are of No. III type (Fig. 1, Fig. 2 in the original paper), larger, further apart, and irregular in shape or crystalline; many are duplex. The ductility of steels with these inclusions is good, but not quite so good as that of those with the Type I inclusions.

The grain size listed in these tables is that of the steels as normalized from 1650 deg. F., the condition in which they were tested. There is but small variation, the aluminum deoxidized steels having the smallest grain size, and the titanium deoxidized steels showing an advantage over those with no special deoxidizer. [Grain size micrographs are shown in the paper as presented but are omitted here.]

Mechanical Properties

Room Temperature Tests: Table II gives the mechanical properties of the steels. All are normal for class B steel and can be accounted for by composition and deoxidation practice. The yield and tensile strengths follow the composition very closely; they are slightly higher than those ordinarily obtained commercially for similar compositions because the individually handled laboratory bars cooled somewhat faster. High carbon or high manganese, or both, produce high strength. The chromium and nickel content has increased the strength of Heat E-1, but the copper in the triplex steels has a negligible effect. The low temperature anneal caused a slight average drop in the yield strength, but had no effect on the tensile strength.

The ductility tends to vary with the composition decreasing as carbon or sulphur, or both, increase. The inclusion type, however, has a strong effect, and all the steels with the No. I type have very good ductility. All three steels with the No. II type inclusions have poor ductility, though this is due in part to the high carbon content. All the steels with the No. III type inclusions have good ductility, but average a little lower than those

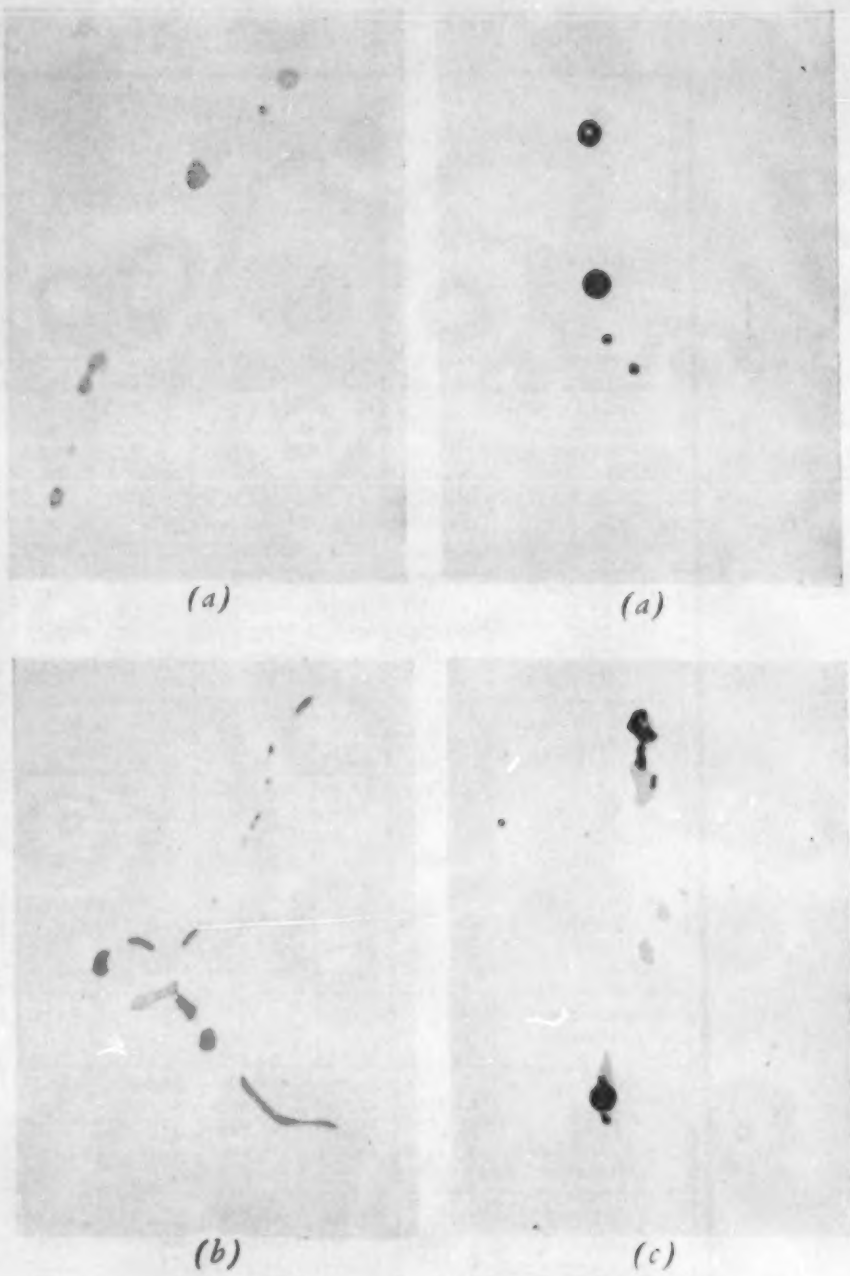


Fig. 1. [Fig. 2 in the original] Types of inclusions found in cast steels. Unetched. 500X. (a) Type I inclusions. (b) Type II inclusions. (c) Type III inclusions.

with the No. I type. The triplex steels run a little lower in ductility than the others with this type inclusion; their lower ductility cannot be accounted for entirely by composition, but some of the inclusions in these heats are close to the No. II type.

Hydrogen: Hydrogen embrittlement, as indicated by the improvement of ductility produced by the draw, is present in the basic open-hearth Heat 9551, acid electric Heat 1163, basic electric heat E-1, and the converter steels 1, 2, 3, 4, A and B. This indicates a greater prevalence in the converter steels, though some trouble with hydrogen is not uncommon in the other steels. There is some indication that present practices tend to minimize this trouble.

Brinell Hardness: Brinell hardness numbers of sections cut from the center of the coupons follow the tensile strengths very closely.

Table II. Mechanical Properties of Grade "B" Cast Steels

Steel No.	Yield Strength, psi. As Normalized	Yield Strength, psi. As Normalized and Drawn	Tensile Strength, psi. As Normalized	Tensile Strength, psi. As Normalized and Drawn	Elongation, Per Cent As Normalized	Elongation, Per Cent As Normalized and Drawn	Red. of Area, Per Cent As Normalized	Red. of Area, Per Cent As Normalized and Drawn	Brinell Hardness As Normalized and Drawn	Impact Strength, Ft.-Lbs. As Normalized and Drawn Izod	Impact Strength, Ft.-Lbs. As Normalized and Drawn Charpy	A.S.T.M. Grain Size, Normalized and Drawn	Type of Sulphide Inclusions
Acid Open Hearth Steels													
493	49,000	46,500	74,500	74,500	33.5	32.0	57.0	55.5	147	34	25	7-8	I
509	46,000	43,000	75,000	75,000	33.0	34.0	57.0	56.5	142	32	24	7-8	I
F-1	46,500	46,000	84,000	83,000	28.0	29.0	47.0	46.5	162	22	18	6-7	I
F-2	49,000	47,500	86,500	87,000	29.5	29.0	49.5	49.5	169	22	18	6-7	I
Basic Open Hearth Steels													
9551	45,000	45,500	74,000	75,500	29.0	33.0	38.0	56.5	144	40	27	6-7	I
9567	46,000	46,000	78,000	79,500	31.5	32.5	56.5	57.0	150	36	26	7	I
O-1	48,500	46,500	82,500	81,500	31.0	31.5	52.5	52.5	162	34	22.5	7	I
O-2	47,500	48,000	80,000	80,500	32.0	33.0	53.5	55.5	157	29	24	6-7	I
Acid Electric Steels													
715	56,000	48,000	83,000	81,000	28.5	28.5	49.0	49.5	165	28	20	8	I
724	52,500	47,500	80,000	80,000	30.5	30.0	54.0	54.0	157	29	23	8	I
1009	50,500	49,000	82,500	82,000	29.0	30.0	53.0	52.0	162	25	20	7	I
1025	47,000	47,000	78,500	78,500	32.0	30.5	53.0	54.5	155	27	21.5	7	I
1163	47,000	46,000	75,000	75,000	27.0	29.0	40.0	45.0	142	..	22	7-8	III
Basic Electric Steels													
E-1	59,000	60,500	92,000	93,500	20.0	23.0	26.5	33.0	188	19	12	7-8	II
Converter-Acid Electric Steels (Triplex)													
H-30	58,500	53,500	84,500	87,000	28.0	26.0	44.5	35.5	170	34	19	8	III
H-34	58,000	55,500	87,500	87,500	25.5	24.5	35.0	37.0	174	33	18.5	8	III
H-38	47,500	47,500	81,000	81,000	20.0	24.0	29.0	33.5	157	27	15	6-8	III
H-42	61,000	55,500	90,000	91,500	23.0	23.5	32.0	30.0	176	21	13	8+	III
Converter Steels													
1	53,000	53,500	80,500	81,000	29.5	31.0	45.0	49.5	155	38	21	8	III
2	47,500	46,000	74,500	75,000	28.0	33.0	42.5	55.5	146	44	28	8	III
3	48,500	48,000	76,500	77,500	27.0	31.0	44.5	53.0	152	42	26	7-8	III
4	47,000	47,000	72,500	73,500	29.0	31.0	47.0	50.0	143	43	25.5	8	III
A	46,000	44,500	77,000	76,500	28.0	31.5	40.5	52.0	148	28	23	7	III
B	59,500	58,500	87,500	88,000	19.0	24.0	22.5	34.5	172	26	13	8	II
C	55,500	55,000	85,500	85,000	22.5	23.5	32.0	31.0	168	30	13	8	II
D	52,000	50,000	81,000	80,000	27.0	30.0	47.0	48.5	157	39	23.5	7-8	III

Note: Tensile values and Charpy impact values are averages of duplicate tests. Izod values are averages of three tests.

Notch Bar Impact: Notch bar impact tests were made on V-notch Izod specimens and on keyhole-notch Charpy specimens; both, in general, bear a close correlation to the ductility. Comparing steels with the same ductility, however, it is apparent that the aluminum deoxidized steels have the highest average impact ratings, whereas those treated with titanium show no advantage over those without a special deoxidizer. Most of the aluminum deoxidized steels are converter steels but, because this effect of aluminum is well known, no significance is given to the method of production.

Low-Temperature Impact

Low Temperature Notch Impact Tests: Though properly aluminum-killed Bessemer steel pipe of 0.15 per cent C is known[5] to have good shock resistance at low temperatures, one of the properties in which cast converter steel has been alleged to be especially vulnerable is notch sensitivity at low temperatures. In the present study, therefore, considerable attention was given to low temperature notch-bar impact tests on standard keyhole-notch Charpy bars, both single and double width. It is well known that such tests differentiate sharply between steels properly and improperly deoxidized, whereas static tensile properties at low temperatures do not.

The specimens were cooled by immersion for 15 min. in a bath of acetone and dry ice, and were broken within 3 sec. of the time they were removed from the bath. The bath was agitated, and was held at 3 deg. F. below the desired breaking temperature, to allow for temperature increase in handling the

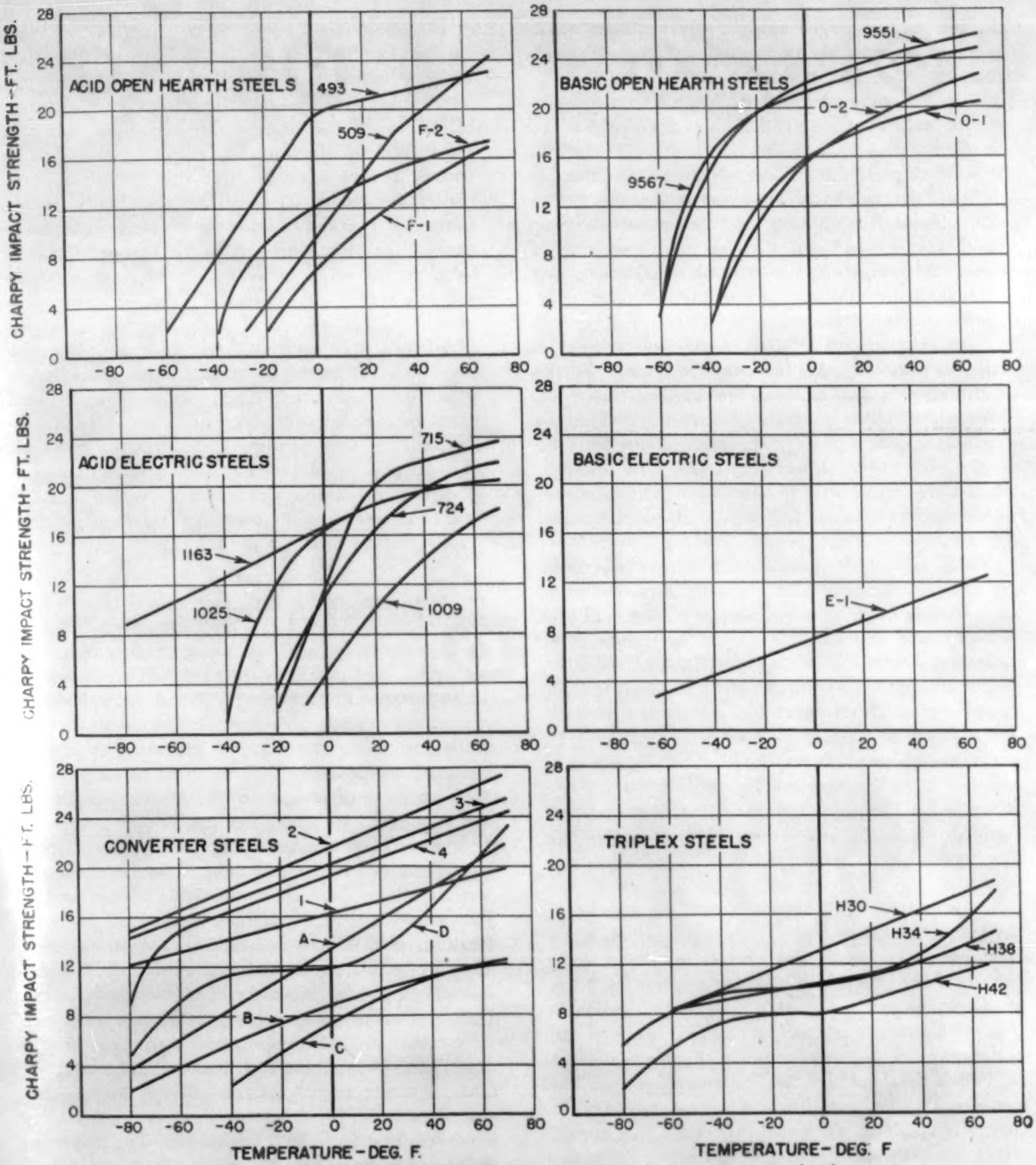


Fig. 2. [Fig. 5 in the original] Low temperature impact strength of cast steels. (Curves plotted from min. values in Table III.)

specimen. The tests were made in duplicate, and check tests were made where the original duplicate tests gave erratic results. A table [not reproduced here] lists the maximum and minimum values for single width specimens, and the minimum values are plotted in Fig. 2. [Fig. 5 in the original.]

The impact values gradually decrease with drop in temperature until suddenly they become very erratic or drop to a much lower figure. It is this drop-off, where the steels change from a relatively tough to a brittle material, that is important to determine. Where duplicate tests give such values as 17 and 2

ft.-lbs., chance might easily give two high values or two low ones, so that individual figures are much less important than trends.

The first acid open-hearth heat begins to show erratic values at —20 deg. F., the second and third at 0 deg. F., and the fourth at —20 deg. F.; at —40 deg. F., three show extremely low values.

The first two basic open-hearth heats show no drop-off until —60 deg. F., the next two drop off sharply at —40 deg. F. The good properties of these steels, which had no special deoxidation, may be attributed tentatively to the relatively low phosphorus content.

The first two acid electric steels gave erratic results at —20 deg. F., the third at 0 deg. F., the fourth at —40 deg. F. Heat No. 1163 of this series, however, exhibits no erratic behavior, but only a gradual reduction in impact values down to —80 deg. F., the lowest temperature used. The first four steels were treated with titanium and calcium, whereas the last was deoxidized with 2 lbs. of aluminum per ton.

The basic electric heat, starting rather low, shows no inconsistency and falls gradually to a low value at —60 deg. F. The nickel content of 0.43 per cent is thought to be of benefit in this steel because the aluminum content is too low for the best effect.

The triplex steels hold up very well down to —60 deg. F.; Heat H-42, which has a low value at room temperature, shows erratic behavior at —40 deg. F., but none of them shows a reduction to less than half the room temperature value until —60 deg. F., is reached. The copper content of these steels undoubtedly aids the low temperature properties, but they were also deoxidized with 2 lbs. of aluminum per ton.

The converter steels, Heats Nos. 1 to 4 inclusive have easily the best low temperature properties. Only Heat No. 4 begins to show erratic results at —80 deg. F. All of these steels had an addition of 2 lbs. of aluminum per ton. Heats A, B and C, to which 1 lb. of aluminum per ton was added, begin to fail in the range of —20 to —40 deg. F., whereas Heat D, to which about 1.5 lbs. of aluminum per ton was added is consistent down to at least —60 deg. F. Generally speaking, all specimens which give impact values less than about 5 ft. lbs. had brittle fractures, while those above this figure showed some toughness.

Superficially, these low temperature notch bar impact values seem to show a distinct advantage for converter (including triplex) steel, but the evidence of acid electric Heat 1163 and the converter steels B and C clearly indicates that the melting medium is of secondary importance at best, and that the deoxidation practice is paramount. The value of deoxidation and aluminum additions in enhancing the low temperature toughness of steels has been shown by Herty[6], and by Kinzel, Crafts and Egan[7].

Double Width Charpy Bars: As a further check on the low temperature notch brittleness of these steels, a limited number of double width Charpy bars were broken at temperatures in the region of the drop-off shown by the single-width bars. As shown by Hoyt[8], and by McAdam and Kline[9], a double width Charpy bar of a tough steel will require approximately double or at least a substantially greater amount of energy to break than a single width specimen of the same steel. A brittle or notch-sensitive steel, on the other hand, will break with considerably less energy absorption for a double width specimen.

All tests were made in duplicate at each temperature used. It might be expected that these results would show a different trend or be more erratic, than those for single width tests, but they present substantially the same picture. In general, the first signs of brittleness are observed at slightly higher temperatures with the double width specimens, but in a few cases, the reverse is the case. [Table showing these results omitted in this summary.]

Strain Age Hardening Effects

The ability of a material to retain its impact strength after strain age hardening is often considered of importance in evaluating it for some applications. As converter steels have been considered to be especially susceptible to strain age hardening effects, because of a supposedly high nitrogen or oxygen content, a number of comparative tests were made on cast steels.

Specimens of the normalized and drawn coupons were machined to oversize dimensions for the standard impact bar, and these were then compressed in the center for about ¼-in. on either side of the notch location, until they were cold worked 10 per cent. They were then finish machined to size and the keyhole notch put in the center of the worked portion. Four specimens were machined from each steel; two were tested as cold worked, two were aged at 475 deg. F. for 30 min. and then tested at room temperature. Average results obtained in the impact tests, and Rockwell "B" hardness data are given in a table [omitted from this summary]. The major increase in hardness of the steels occurs after cold working, the aged specimens showing only minor differences in comparison with the cold worked specimens.

Impact strength values (best illustrated in the per cent reduction figures), show marked reduction, the major portion of which occurs in some of the steels after cold working, and in others after aging. Some relationship is evident between these data and the deoxidation practice used. The steels having no strong deoxidation treatment, as a rule, are much more susceptible to aging after cold working than are the

fully deoxidized steels. The latter have the major reduction in impact strength occurring after cold working, as will be observed in the tests on the converter group of steels. The two basic open-hearth steels, Nos. 9551 and 9567, are apparent exceptions to this rule and show good resistance to strain aging.

Fatigue Properties of Cast Steels

The fatigue or endurance strengths of the grade "B" steels has assumed an importance greater than normal during the present emergency. As very few data are available on cast steels which could be used in comparing the various steels produced by the different melting units, a few tests were made on representative steels from each group. Two types of specimens were run in the tests, standard specimens and Kommers square notched specimens. Two of the steels, the acid electric steel No. 724 and converter steel No. 3, were also tested at —40 deg. F., using apparatus described elsewhere[10].

The fatigue data obtained are completely tabulated in the original paper. The standard specimens show a distinctly higher endurance ratio for the two acid steels than for the basic and converter steels, but as only one heat from each group was run, no generalization can be made.

The notch endurance tests at room temperature, on the other hand, have a striking uniformity which shows no preference for any group, and the two steels (acid electric, No. 724, and converter steel No. 3,) tested as notched bars at —40 deg. F. gave very similar results. Since steel No. 724 had only 2 ft.-lbs. Charpy impact resistance at —40 deg. F., it is evident, as might have been expected, that fatigue properties do not reflect the type of brittleness brought out by single blow notched bar impact tests, but instead fall in line with the static tensile properties. All the endurance limits are within normal expectations, and do not appear to be influenced by deoxidation practices in the same manner as some other properties tested.

Summary of Results

Commercial cast steels of normal composition made by six processes were compared as to composition and mechanical properties.

The basic open-hearth steels had lower phosphorus contents, but if the identification were to be removed from the others, it would be difficult to decide by what process they had been made.

The converter steels, as a group, were deoxidized with aluminum, whereas only two of the other steels were aluminum killed.

The microstructures were governed by the deoxidation practice, both as to inclusion type and grain size. Aluminum was the only deoxidizer that caused a definite change in type of inclusion. Titanium produced some grain refinement but not so much as aluminum.

The room temperature mechanical properties were entirely orthodox for grade "B" cast steel, and varied with the composition, deoxidation practice, and type of inclusions, without regard to the method of manufacture.

The converter steels, as a group, had the best low temperature notch bar impact properties, but this is held to be a result of deoxidation with aluminum, rather than melting practice. Acid electric steel, deoxidized with aluminum, had good low temperature notch bar impact properties.

The aluminum-killed steels also showed less strain age hardening, which gave a fallacious advantage for the converter steels.

A limited number of standard fatigue tests showed a superiority in endurance ratio for the acid open hearth and acid electric steels, but notched fatigue tests showed a notable similarity for all steels.

No evidence was found to favor one process over another, except that the basic open-hearth gave better phosphorus control.

When low temperature shock resistance is needed, it would be in order to impose a low temperature notched bar impact acceptance test, rather than to exclude any process of steel making.

With proper deoxidation, all the processes can make steel of the qualities demanded for war purposes.

Bibliography

[1] W. C. Hamilton. "General Survey of the Steel Castings Industry," Am. Soc. Testing Materials, 1932, pages 7-11.

[3] C. E. Sims and F. B. Dahle. "Effect of Aluminum on the Properties of Medium Carbon Cast Steel," *Trans. Am. Foundrymen's Assoc.*, Vol. 47, 1938, pages 65-132.

[4] C. E. Sims and G. A. Lillieqvist. "Inclusions—Their Effect, Solubility and Control in Cast Steel," *Foundry Trade J.*, Vol. 47, Aug. 11, 1932, pages 77-82; *Trans. Am. Inst. Mining Met. Engrs.*, Vol. 100, 1932, page 154.

[5] H. W. Gillett. "Impact Resistance and Tensile Properties of Metals at Subatmospheric Temperatures," Project 13, Joint A.S.M.E.-A.S.T.M. Research Comm. on Effect of Temperature on The Properties of Metals, Aug. 1941, page 33.

[6] C. H. Herty, Jr., and D. L. McBride. "Effect of Deoxidation on The Impact Strength of Carbon Steels at Low Temperatures," Carnegie Inst. of Tech. and Min. & Met. Advisory Boards, *Cooperative Bull.* 67, 1934, 52 pages. Abstracted in *Metals and Alloys*, Vol. 6, Mar. 1935, pages 71-77.

[7] A. B. Kinzel, Walter Crafts and John J. Egan. "Fine Grained Structural Steels for Low-Temperature Pressure Vessel Service," *Metals Tech.*, Vol. 4, April 1937, 24 pages.

[8] S. L. Hoyt. "Notched-Bar Testing and Impact Testing," *Proc. Am. Soc. Testing Materials*, Vol. 38, Part II, 1938, pages 141-156.

[9] D. J. McAdam, Jr., and R. W. Clyne. "The Theory of Impact Testing: Influence of Temperature, Velocity of Deformation, and Form and Size of Specimen on Work of Deformation," *Proc. Am. Soc. Testing Materials*, Vol. 38, Part II, 1938, pages 112-134.

[10] H. W. Russell. "Effect of Low Temperatures on Metals and Alloys," Symposium on Effect of Temperature on The Properties of Metals, Am. Soc. Testing Materials, 1931, page 658.

Editorials *(Continued from page 44)*

In precipitation-hardened alloys, the situation is much as is the case with fillers in rubber,—one inert material of a given particle size and shape acts pretty much like another. The composition of the particular compound that is precipitated in the alloy is not the prime factor; it's where it precipitates and in what dimensions.

In the mild-alloy steels, in depth-hardening and in precipitation hardening, there is increasing evidence that a multiplicity of ferrite-strengtheners, or hardenability-producing elements, or of precipitable compounds, each in relatively very small amounts, is much more effective than a lot of one only. One suspects that this harks back to lattice distortion of the matrix crystals by intrusion of stranger atoms and foreign particles, and if the atomic or molecular fields of force set up by these intruders vary, those of smaller force fields can range themselves in between those of larger fields to produce a sort of close-packing effect characteristic of properly proportioned particles of a range of sizes.

There will be differences in behavior due to differences in melting points, thermal stability, etc., of the reinforcing atoms and molecules and aggregates, in the time-temperature limitations in processing the alloys, and in the dimensional changes accompanying phase changes and precipitation effects which will, in fine-haired differentiation, lead to preferences for those that are least sensitive to minor variations, or have other advantages.

But it looks as though there is rapidly approaching the day of "Irish Stew" alloys, with ingredients chosen for a blending of many flavors, and with a wider range of choice among the ingredients than we ever dreamed would make good stew.

The point of view that alloying elements act more as mechanical building blocks or reinforcing bars, than as chemicals, is being made more and more acceptable. The next generation of metallurgists will probably approach its problems from a more mechanistic point of view than the present one. —H.W.G.

Alloy and Electric Steel in 1941

Our expectations that some records would be made by the American alloy and electric steel industries last year have been realized. Statistics, released this month by the American Iron and Steel Institute, show that some striking records and developments have resulted.

Over 8,000,000 net tons of alloy steel—8,174,961 tons to be exact—was the 1941 record. The outstanding facts here are that this is an increase of 64.7 per cent over the 4,965,-887 tons in 1940 and that it is 9.87 per cent of the total steel made. Never before have these heights been attained. The alloy steel in 1940 was only 7.41 per cent and in 1929 it was 7.01 per cent of the total steel, the best record previous to 1940.

In stainless steel a new total was also hung up last year—371,984 tons which is 48.8 per cent over the 249,980 tons for 1940. A feature here is the marked increase last year in the relative amount of the plain chromium types—due in part to the obligatory use of less nickel.

As to electric steel, the data are fully as striking and interesting. A 70 per cent increase was made last year in the steel that came from electric furnaces—2,869,256 tons as contrasted with 1,700,006 tons in 1940. And here again a feature is the fact that the 1941 total was 3.46 per cent of the country's total steel output. In 1940 this figure was 2.54 per cent, a record then.

The expansion of the use of the electric furnace in the alloy steel industry is reflected in the fact 30.1 per cent of the alloy steel was made by this process—another new record. It was 25.8 per cent in 1940, a high then, and only 12.9 per cent in 1929.

The high place which has been attained by alloy and electric steel in our expanding steel industry is revealed and emphasized by the foregoing facts. The acceleration in output is due of course to war demand. But it is noteworthy that the large volumes were attained in spite of the situation in such strategic metals as nickel, chromium and others. —E. F. C.

Peg Allen's new coffee maker is helping to bring down Stukas

"I'm rushing down right now to buy another Defense Bond and get even with Hitler and the Japs! I just found out I can't get the automatic coffee maker that I've been dying to have, because the manufacturers of household appliances are making nothing but munitions. So the coffee maker and the money I'd saved will both *be helping to win the war!"*

Nowhere else on earth have household electrical appliances been so numerous, so ingenious, so inexpensive as in America. When the manufacturers in this great industry turned all their resources to building munitions, they struck a heavy blow against the Axis.

But a conversion as drastic as theirs posed some knotty problems. New designs and specifications required many new alloys, tools and methods. In cooperation with the Revere Technical Advisory staff, a number of the leading appliance manufacturers were able to change over with gratifying speed and ease. For Revere supplies industry not only with sound copper alloys, but also with a highly experienced service in the most efficient methods of using them.

Today, every ounce of copper goes directly into the essentials of modern warfare. There is none for any other use. Fortunately Revere was prepared, with new plants, advanced processes, improved equipment, to assume an important responsibility in the production of our nation's vital copper alloys. And additional facilities are steadily being added to help make victory still surer and quicker.

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DESULPHURIZING IN CONVERTER STEEL PRACTICE

by George S. Evans,

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New York, N. Y.

Side Blow Converter

Prior to the advent of desulphurizing cupola iron by ladle treatment and the practice of melting high percentages of steel scrap in the cupola, converter steel foundries were limited to the use of high-priced raw materials. Even with the best available materials, it was impractical to produce steel castings by the converter process with sulphur contents much below .07 to .09%. However, with desulphurizing, it is now possible to use an all-scrap steel and ferro-silicon charge in the cupola and produce uniformly high quality steel with sulphur contents well under .05%. The refining which comes with desulphurizing carries through to the finished steel casting; thus, it is now possible to produce steel castings with the side-blow converter which meet the most exacting specifications.

With good cupola melting practice and efficient desulphurizing operations, sulphur in the iron from the cupola spout can be regularly reduced by 60 to 70% with Purite and upwards of 75 to 80% with equal parts of Purite and flake caustic soda. Caus-

TABLE I

Table illustrating percent sulphur reduction obtainable on cupola iron in one ladle treatment with varying quantities of Purite per ton.

Before Treatment		*After Treatment in Ladle*				
Sulphur in Iron		*Pounds Purite Per Ton*				*Percent*
at Cupola Spout		*10#*	*20#*	*30#*	*40#*	*Reductions*
0.15%	Sulphur	.07%	.055%	.045%	.040%	55% to 73%
0.12	"	.06	.048	.042	.036	50 to 70
0.09	"	.055	.045	.037	.032	40 to 65

Proportionate percentage sulphur reductions can be expected with similar treatment of higher or lower sulphur irons. Somewhat greater reductions will be obtained with the use of mixtures of Purite and caustic or with straight caustic soda.

tic soda absorbs moisture from the air and must be stored and shipped in air-tight containers. As the name implies, it is highly caustic and must be handled with gloves. It is highly volatile at the temperature of cupola iron and gives off copious volumes of fumes. For these reasons its use is generally to be avoided except in the production of extremely low sulphur specification steel castings.

Granular soda ash may be used for desulphurizing in the ladle. However, it is dusty, produces an excessive volume of fumes, and if used in a damp state is liable to cause a violent explosion. Purite is pure fused soda ash, cast in convenient 2-pound pigs prepared especially for desulphurizing. The pigs penetrate the slag and melt gradually, causing continuous agitation of the bath with a minimum volume of fumes. Purite is generally safer to use and more efficient than other forms of soda ash.

Efficient Desulphurizing Practice

The most important factors in efficient desulphurizing practice are clean metal free of cupola slag or any silicious impurities, and rapid and intimate contact between the metal and desulphurizing slag. To insure clean iron from the cupola use plenty of limestone, along with 1 to 4 pounds of Purite per ton as required to produce a good volume of fluid active refining slag in the cupola, and always stop off the tap before any slag shows on the stream of iron in the spout. The Purite, besides making a more fluid slag which will rise out of the iron in the hearth of the cupola, helps to reduce oxidation of the metal in the cupola, which is noticeably higher when melting steel scrap. The Purite also prevents some sulphur pick-up during melting. This effect is particularly noticeable on the first iron when using large quantities of stone and Purite on the bed and first few charges, the practice now generally followed at most foundries.

The Purite slag is neutralized by any cupola slag or silicious materials present, which both dilute the slag and dissipate its desulphurizing value. Therefore, the ladle should always be free of loose dirt or slag before adding Purite and every precaution should be taken to prevent any cupola slag coming out with the metal.

The stream of iron flowing into the desulphurizing ladle promotes slag-metal contact due both to the physical effect of the stream in stirring the metal and to its action in whipping portions of the freshly melted or undecomposed alkali down into the metal bath. This not only increases the extent of slag-metal surface contact, but makes for more effective contact because of the pressure of the overlying metal. Moreover, decomposition of the reagent under the metal surface with the consequent evolution of gases, causes a violent boiling action which acts to further increase slag-metal surface contact.

To insure both clean iron and maximum surface contact between the Purite slag and metal, the cupola tap hole should be smaller than average so as to extend the tapping time over a longer period, thus prolonging the stirring action by the stream of iron; and a small head of iron should always be held back in the cupola at the end of each tap to prevent any cupola slag coming out with the last iron.

Adding Purite to the Ladle

When desulphurizing in 1 to 3 ton capacity ladles with two cupola taps required to fill the ladle, about 2/3 of the Purite should be added in the bottom of the ladle before the first tap and the balance just after stopping-off the cupola. The first charge of Purite gradually melts providing a good volume of a constantly active slag which is continuously whipped into the bath by the stream during the tap. The second addition of Purite penetrates the slag and melts in contact with the metal, gradually releasing fresh or undecomposed alkali which causes continued boiling action and makes for maximum slag-metal surface contact throughout the tap.

If three cupola taps are required to fill the ladle, add ½ of the Purite at the start and ¼ after the 1st and ¼ after the 2nd tap. If it is the practice to fill the ladle with one continuous tap, add ½ to ¾ the Purite in the ladle at the start and feed in the remainder during the last half of the tap.

In treating one or two ton capacity ladles, the pigs of Purite making up the 2nd and 3rd additions can be placed around the top edge of the ladle before making the first tap. In this way the Purite is warmed up before being pushed into the slag bath, and besides saving some temperature loss, avoids any danger from splashing which might be caused by the use of cold or damp material.

Timing the Reaction

The time required for completion of the reaction, which is indicated in part by quieting down of the Purite slag, will usually vary from 5 to 10 minutes after the last tap in 1 to 3 ton ladles to upwards of 15 to 20 minutes in larger capacity ladles. The operation should be timed as found by experience to give the best results and the practice thus established should be followed from day to day.

At the end of the boil the slag must be thoroughly skimmed off before pouring into the converter. Although traces of slag going into the converter are not harmful to the quality of the steel, any slag attacks the lining just that much and an excess will cause a foamy blow or bad heat, besides returning some sulphur into the iron. The Purite slag is very fluid but can be thickened with additions of slacked lime or ground limestone, or frozen by pouring water on the surface of the slag to facilitate skimming. Sand or any silicious material used in thickening the Purite slag causes a reversal of the reaction and should never be used where maximum desulphurizing is required as in converter steel practice. A wooden hoe-like skimmer coated with mud by dipping in a bucket of grout is preferred over the usual iron skimmer.

Ladle Linings

A hard rammed high-grade plastic fire brick or gannister lining is generally preferred for smaller capacity ladles of one ton and under. For larger capacity ladles a double thickness lining made up one course of brick against the shell and an inside rammed gannister lining or two courses of brick is recommended. The inside lining should be laid up with tight joints either dry or with a very thin grout made of high-grade fire clay. Dense hard burned brick of the type generally used in steel mill ladles which expand and cement at the joints upon being heated up by the first metal will usually give the best life in desulphurizing ladles.

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Wartime Problems Engage the A.S.T.M.

A REPORT OF THE ANNUAL MEETING, ATLANTIC CITY, JUNE 22-26

By THE EDITORS

Cooperation can move mountains! No more striking demonstration of this aphorism exists than the annual meeting of the A.S.T.M., world's champion cooperating society. And few more noble instances of cooperation exist than that of the self-sacrificing METALS AND ALLOYS editors, who tore themselves away from their New York City desks last month to report this Atlantic City meeting for you in these pages.

FOR GRIM, BUSINESS-like activity, nothing can compare with a wartime convention of the American Society for Testing Materials. The annual meeting of the Society, held in Atlantic City the week of June 22nd, was a model of hard work, with the specter of a matériel crisis haunting the collective members and guests. If the convention could be said to have a "theme," it certainly would have been *"Hurry, hurry."*

This report will be confined in general to the outstanding metallurgical engineering features of the meeting, with special emphasis on the heavily-attended radiography symposium. Some current trends as revealed in various reports and papers are also cited.

Executive Committee's Report

The annual report of the Society's executive committee is always a feature of the annual meeting. Only one or two items in this voluminous report can be touched on.

Emergency Alternate Specifications: A paramount theme discussed is the Society's contribution to the War Effort. This is the second time in its history as an incorporated Society that A.S.T.M. has been in a war period. Many branches of the Society's work have been affected by the emergency — the greatest in the ferrous and non-ferrous fields. At no other time have there been so many technical men working on specifications and so much intensive cooperative effort devoted to agreeing on standards, many of them of an emergency nature.

A number of committees have found it desirable to issue emergency alternate specifications which can be invoked by the buyer in the interest of procurement or conserving critical materials. Unquestionably the work of the standing committees in developing these emergency items has been "one of the outstanding developments" during the year. Other emergency changes will be forthcoming. It should be understood however that these emergency changes are not permanent as altering the standard or tentative standard specifications.

Radiography—General Aspects

The overflow crowd that attended the radiography sessions testified to the great increase in interest in and importance of this subject since the society held its first radiography symposium in 1936. In the symposium this year, 13 papers were presented, ranging from Don McCutcheon's general review of practical radiography as applied to today's production conditions, to a brace of papers by Schier & Doan on the use of "equivalent penetrameters." L. W. Ball, of the Canadian National Research Laboratories, presented 3 papers, one of which—on gamma ray technique—in our estimation (and that of more competent observers, too) will rank as a classic in the radiographic field.

The first paper in the symposium, given by Don M. McCutcheon of Ford Motor Co. presented "Some Aspects of X-ray Inspection Applied to Testing and Production." The currently great interest in radiographic inspection he ascribed to the high-volume production of light alloy castings, and the extension of high strength steel castings into fields formerly dominated by forgings.

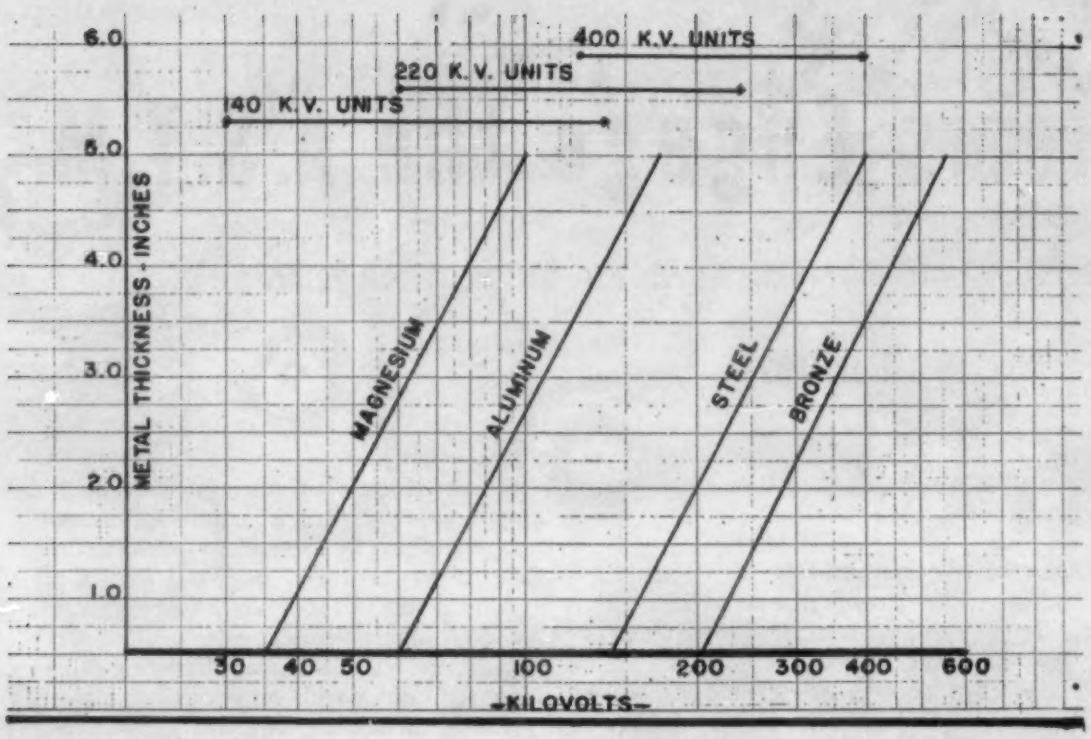
A special class of casting, made by the centrifugal process, is receiving increasing attention in armament manufacture. Centrifugal castings, inspected by X-ray and magnetic methods are being employed for very highly-stressed parts with distinct advantages from the manufacturing viewpoint, and often with superior performance.

The radiographic equipment and technique used in any industrial case depend directly on the metal being tested and its thickness. The light metals have X-ray absorption values that require low-voltage equipment to secure the maximum differential of absorption with thickness. Steel, brass and other heavy metals require a higher-voltage, more penetrating radiation.

The ideal voltage range suitable for the various metals is shown in the table. At the top of the chart is indicated the useful voltage range of the common commercial X-ray units available today. It can be seen that the 220-kv. equipment is most universal in range and application. The 140-kv. units are most efficient for the light metals, and the 400-kv. machines most suitable for heavy steel, brass or bronze castings. The million-volt X-ray machines recently introduced to commercial use will be discussed later.

Table of Recommended X-ray Filter Practice (McCutcheon).

KILO VOLTAGE	APPLICATION	SECTION THICKNESS	FILTER
15-60	MAGNESIUM ALLOYS	1/8" - 4"	NO FILTER AT TUBE OR FILM
30-60	ALUMINUM ALLOYS	1/8" - 1"	NO FILTER AT FILM. COPPER 1/2 MM THICK AT TUBE FOR SPECIAL SECTIONS, OPTIONAL.
60-100	" "	1/2" - 2"	NO FILTER FOR PLAIN SECTIONS 1/2 MM COPPER AT TUBE FOR COMPLEX SHAPES. .002"-.005" COPPER FOIL AT FILM, OPTIONAL.
140	" "	ABOVE 2"	COPPER OR LEAD FILTER .005" THICK AT FILM SURFACE.
125-220	STEEL	1/8" - 1"	LEAD FILTER AT FILM SURFACE .005" THICK. LEAD FILTER AT TUBE, .010" OPTIONAL
220-400	"	1" - 2 1/2"	LEAD FILTER .005" - .025" THICK AT FILM LEAD FILTER AT TUBE .010" OPTIONAL
1000	"	2 1/2" - 5"	LEAD FILTER .005" - .250 AT FILM DEPENDING UPON IRREGULARITY OF SECTION. LEAD FILTER UP TO 1/2" AT TUBE FOR ROUND AND IRREGULAR SECTIONS.



Commonly used voltage ranges for the X-ray examination of four familiar materials. The usable voltage range for commercial X-ray units is shown at the top of the graph (McCutcheon).

Radiography of Light Metals

McCutcheon explained that image sharpness—essential because of the size and distribution of the defects encountered—is a big problem in the radiography of aluminum and magnesium alloys. The procedure best followed is to use the lowest voltage on the X-ray tube consistent with a reasonable exposure time.

Where production is high, the most convenient technique is to establish a reasonable exposure time, and select the voltage required for the section thickness being X-rayed. Exposure times of less than 1 min. should be avoided, and fine-grain high-contrast film should be used if obscure defects must be revealed.

In order to diminish the number of exposures required with complex casting shapes, a long tube-to-object distance is recommended. Where it is not possible to register on the film all the casting sections within an acceptable density range, filtered radiation may be used. A copper filter placed on the tube port may thus be used to increase the coverable thickness.

For aluminum sections over 2 in. thick a thin copper foil (lead foil is used for the heaviest sections) is placed between the object and the film to reduce the scattered radiation produced by the higher voltage required. In the Table are presented recommended filtration practices for various metals section thicknesses and special purposes.

Particularly useful and interesting calibration data on scattered radiation, sensitivity and penetration in X-ray radiography of magnesium castings were presented by L. W. Ball of Canada's National Research Laboratory in a paper "Some Calibration Data and Scatter Measurements for the Radiography of Magnesium Aircraft Castings."

So far as penetration is concerned, 1.9 in. of magnesium alloy is equivalent to 1.3 in. of aluminum or 1.0 in. of duralumin. Also, 55 kv.-p. X-rays penetrate magnesium as easily as 70 kv.-p. X-rays penetrate aluminum. The grain size of

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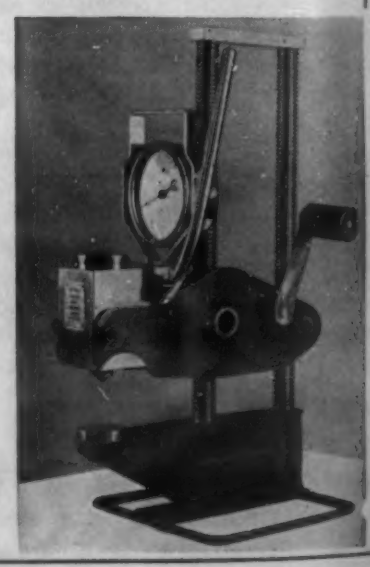

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Throat 4" deep
Gap 10" high — Wt. 26 lb.

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NARBERTH, PENNA.

RANDOM PHOTOS OF CONVENTION-GOERS

1. *Col. G. F. Jenks of the Ordnance Dept. and C. A. Adams of Edw. G. Budd Mfg. Co. relax for a moment.*

2. *Lars Thomassen of Michigan University and L. W. Ball of National Research Laboratories, Ottawa, obligingly face the camera on the boardwalk.*

3. *H. J. French of the War Production Board (left) and Henry Chandler (center) of Vanadium Corp. of America discuss the alloy steel problem while a friend listens closely. Wouldn't you?*

4. *Left to right, J. S. Vanick of International Nickel, J. W. Bolton of Lunkenheimer and E. D. Young of Climax Molybdenum.*

5. *E. E. Smith of Eastman Kodak, Don McCutcheon of Ford and R. J. Van de Graaf of M. I. T. (left to right) are happy about something.*

6. *B. K. Price of "Steel" magazine and C. M. Parker of American Iron and Steel Institute hurrying to a meeting.*

7. *B. W. Gonser of Battelle and G. C. Jenison of Weirton Steel heading for something cool and wet after a hot afternoon meeting.*

8. *A couple of foundrymen—J. T. Mackenzie of American Cast Iron Pipe Co. and N. F. Hindle of the A.F.A.—being serious.*

9. *Dr. H. H. Lester, of Watertown Arsenal, prominent in the organization of the radiography symposium, enjoys an afternoon stroll on the boardwalk.*

10. *R. J. Allen (center) of Worthington Pump & Machinery Corp. betrays shepticism as Alexander Gobus of Lucius Pitkin (left) relates how he once got good radiographs on Verichrome.*

11. *T. D. Parker of Climax Molybdenum Co., E. K. Mull of Bendix Radio and Roger Metzler of Eclipse Aviation having their own little meeting.*

12. *R. F. Thormley of Philadelphia Navy Yard and Noah Kahn of Brooklyn Navy Yard hurrying to the radiography session.*

13 *J. F. Wyzalek of Hyatt and H. C. Weirick of Timken "between hotels."*

14. *And at the apex, Philip D. Johnson of Radium Chemical Co., Inc., calling to order the first meeting of the newly organized American Industrial Radium and X-ray Society, a national organization devoted to the science and practice of radiography.*

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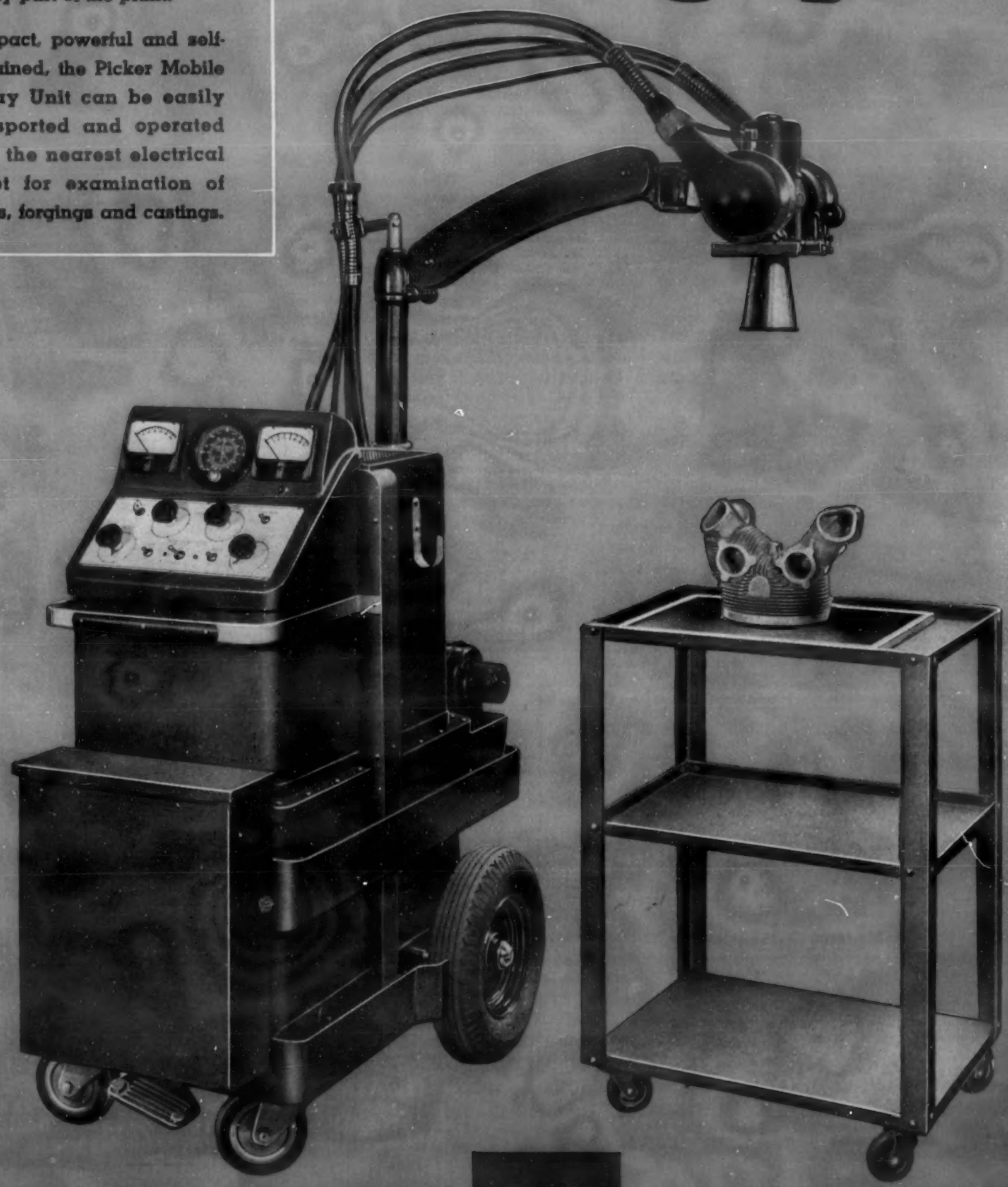
Compact, powerful and self-contained, the Picker Mobile X-Ray Unit can be easily transported and operated from the nearest electrical outlet for examination of welds, forgings and castings.



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MARKS THE SPOT...

OF INTERNAL METAL WEAKNESS

Headaches for the Axis! . . . Not only are America's industrial plants outproducing the *combined* efforts of the Axis with their forced slave labor, but the overwhelming superiority of our war products will be a deciding factor in the United Nation's ultimate victory.

The fact that our guns, planes, tanks, trucks and all other war materiel are superior in every particular, can be attributed in part to the employment of x-ray as an inspection tool for testing purposes.

The old method of checking metals through dissection is much too slow for our geared-up production.

The various applications of x-rays tell the *complete* story of metal structure — in a matter of minutes. Shrinkage, blowholes, pinholes, cracks, porosity, sand and slag inclusions are readily discernable by means of x-ray. To this end Picker Shock-proof Industrial X-Ray Units are playing a significant part in many of our war production plants throughout the country.

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C O R P O R A T I O N

WAITE MANUFACTURING DIVISION, CLEVELAND, OHIO

ordinary no-screen film appears to be fine enough to portray micro-shrinkage in magnesium castings.

Direct tests of the relative sensitivity obtained with magnesium and pure aluminum show that they give very similar results, although the presence of 4 per cent Cu improves the sensitivity of the latter by 30 per cent. Also, weight for weight, magnesium and aluminum actually produce very nearly the same amount of scatter. This blasts a long-standing legend that magnesium produces so much more scatter than aluminum as to make good radiographs unobtainable.

A method of radiographically estimating micro-shrinkage porosity in magnesium castings was described by R. S. Busk of Dow Chemical Co. in his paper "A Correlation of the Mechanical Properties and Radiographic Appearance of Magnesium Alloy Castings."

An attempt was made by Busk to correlate micro-porosity with tensile strength and other properties, and he was able to show that the tensile strength of magnesium alloy castings decreases with increasing porosity, while the yield strength is very little affected.

Lester reported agreement with Busk's findings as to magnesium, but could not always obtain a similar correlation with steel. Other discussors indicated that in production work microporosity can usually be assigned a place of comparatively minor importance, since many factors other than porosity may predominate in their gross effect on physical properties.

Large aircraft construction projects require that many thousands of parts be examined per day. A natural mass-production development, therefore, is the use of a straight-line conveyor type system, as at Ford's Willow Run plant, with the X-ray tube in a lead-lined tower arranged to automatically receive the parts, carry out the X-ray operation, and discharge the parts on the opposite side. An automatic developing machine is even used to process all films during peak production.

A very interesting recent development is the production X-raying of aluminum spot welds. The thinness of sheet being tested requires the use of an X-ray beam generated between 8 and 30 kv. to obtain sufficient contrast. A very small focal spot—less than 2 x 2 mm.—is achieved by the use of a beryllium metal window in place of the usual glass. And finally, a film (Agfa Film Co.'s "Superay B") of unusually high contrast and fine grain is employed.

Million-Volt X-rays

The thickness of metal that may be examined by X-ray between 150 and 400 kv., according to McCutcheon, may be extended by the use of calcium tungstate intensifying screens to the following maximum limits with reasonable exposure time:

150 kv. .....1 in. of steel
220 kv. .....3.5 in. of steel
400 kv. .....5 in. of steel

The necessity for using intensifying screens, and the troublesome and time-consuming "blocking" technique thereby required with heavy sections has been eliminated by the introduction of the million-volt X-ray machines [for a description of these machines and their application, see the December 1941 issue of METALS AND ALLOYS, page 883]. The thickness limitations of lower-powered units and the troublesome scattered radiation were offset to a remarkable degree by the use of the increased voltage.

McCutcheon believes that where the size of the work and the production volume is large, the million-volt unit is an economical investment, particularly in view of the tremendous shortening of exposure times it permits, as compared with lower-voltage or even gamma-ray technique. Interpretation of million-volt X-ray films is not different from lower-voltage practice after one is accustomed to their peculiarities—*e.g.* an apparent low level of contrast that may be misinterpreted as low sensitivity.

It is unfortunate that a number of books and papers on radiography refer to a density of 0.7 as ideal for X-ray films for industrial work, for in million-volt work it has been found that a very rapid de-

Low Cost Combustion Boat Makes One-time Use Practical

The refractory mix of which the boats are made, withstands the high temperature of all alloy combustions . . . the boats do not fuse to tubes and they retain their original shape.

The thick base prevents penetration of the fused sample. Ample inside width of the base gives a large area over which the sample flows freely to form a thin layer. The boats are precisely shaped by die forming, having perfectly straight sides, smooth flat bottoms and an excellent dimensional uniformity.

When used with a cover the boats fit inside a ¾" combustion tube. The outside surfaces of the boats are smooth and the ends have a large perpendicular surface so they can easily be inserted or removed from the tube with the usual metal rake. A sample combustion boat with cover will be mailed without charge upon request.

S-21850 Sargent High Temperature Combustion Boat.

As described. Outside length, 77 mm; outside width, 12.5 mm; outside height, 9 mm; inside length, 72 mm; inside width, 8 mm; inside depth, 5mm. Without cover.

Per 100.....$7.75
Per 500.....31.00
Per 1000.....45.00

S-21900 Cover Only for Sargent High Temperature Combustion Boat.

Per 100.....$7.75
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SCIENTIFIC LABORATORY SUPPLIES

crease in sensitivity is obtained at densities below 1.5. McCutcheon's practice for securing maximum sensitivity and contrast in million-volt work is to employ high-contrast, fine-grained X-ray films, processed to a density of about 2.0. A special viewing box, containing five 15-watt fluorescent tubes, and a few auxiliary photoflood spot lights must be used, but *with it* no loss in detail and sensitivity is apparent in million-volt X-ray films up to densities over 5.0.

A detailed description of General Electric's "portable" million-volt unit—with its Freon gas insulation, resonance transformer without an iron core, and sealed-off multi-section X-ray tube—was given by E. E. Charlton & W. F. Westendorp of General Electric Co.

R. E. Lorentz, Jr., of Combustion Engineering Co. put in several good words for the use of million-volt X-rays in his paper on the inspection of welded vessels. In addition to the great saving in time made possible, there is also the advantage of being able to radiograph vessels from the inside out, as with radium, with a double-film-viewing technique.

The specification of permissible porosity, defects, etc., in welds has not yet been established. Some companies, it was reported, have made "synthetic" defects in experimental welds and found them to be less detrimental than is generally supposed.

One useful kink was brought into the discussion of the "wrap-around" technique. Lead screens wrinkle when bent around the vessel being tested; this may be overcome by backing the lead with aluminum. General Electric was mentioned as having a rubber-like (non-wrinkling) material that can be used in place of lead for screening.

Canadian Blitzkrieg

Both of the careful readers of this report must have noted the ubiquity therein of L. W. Ball, who presented 3 of the 13 papers in the radiography symposium. Dr. Ball (not to be confused with H. J. Ball, A.S.T.M. vice-president) came all the way from Ottawa to banish a lot of radiographic guesswork and argument with some well-planned measurements. In this entirely successful blitzkrieg he enjoyed the worshipful support in the audience of about 6 Canadian girls, now studying under Dr. H. H. Lester at Watertown Arsenal before returning to the Dominion as full-fledged inspectors.

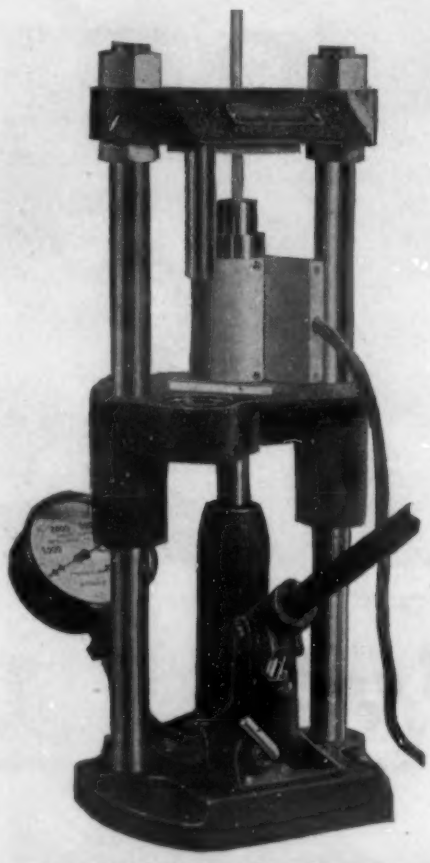
Ball is engagingly shy and isn't going to care for this at all!

Radium or X-rays—Which?

Another discussion of million-volt X-rays for inspecting heavy fabrications was a paper by O. R. Carpenter of Babcock and Wilcox Co. Some of his comments about gamma-ray and high-voltage X-ray are of particular interest. In general, he believes that gamma-ray with modern fine-grain film gives better results on certain plate thicknesses than the million-volt machines in the higher voltage ranges, if time is not important.

In his paper McCutcheon had offered a few comparative data on gamma-ray and X-ray work, warning his listeners, however, that comparisons were often unfair because they do not embrace the maximum operating efficiency for each method. McCutcheon favors radium where the volume of work is small and the work is heavy—say heavy castings—but likes the million-volt unit for large volume work. On one part, the million-volt unit can examine 64 times the volume formerly X-rayed on the 400-k.v. unit and 24 times the volume possible with radium of average amount in the same floor area.

Several men mentioned the outstanding advantage of field portability of radium where X-ray, particularly ultra-high voltage machines, would be difficult or impossible to handle. It is the "simplicity and greater adaptability" of radium, for example, that makes it preferable to X-rays for radiographing welded piping, in the eyes of R. W. Emerson of Pittsburgh Piping and Equipment Co., who gave a paper on gamma-ray radiography of welded high-pressure power plant piping.



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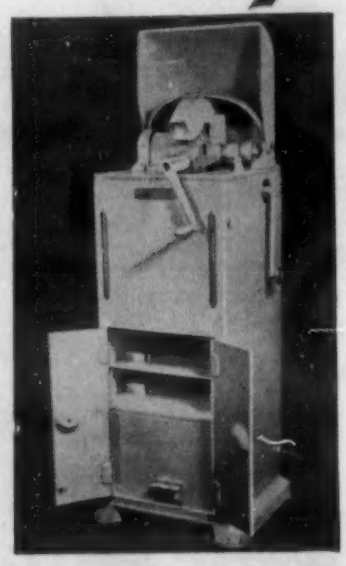

Because cutting wheel, vise and specimen are all wholly submerged in water in this new type specimen cutter, over-heating and burning of the sample is completely eliminated . . . As foreign particles are washed away by action of the water, burring is also prevented and intermediate grinding or machining of the cut surface before mounting is unnecessary. Specimens up to 8 inches long by 1¼ inches in diameter may be cut on this machine in a matter of seconds.

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The IMPRESSOR comes packed in a fitted case appropriate for carrying or storage. A protecting cap is furnished for the indentor point.

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The Right People

The round table discussion on alternate steels and conservation was entirely off-the-record, and in fact seemed to be somewhat hamstrung by the speakers' fear of revealing something new. We think we can take some editorial license, however, and pass along the concluding remarks of Colonel Frey, who explained and defended Ordnance practice in setting up and holding to quality specifications. "This equipment we're making," he said, "is designed and built to kill people. We want to be sure it kills the right ones!"

No subscriptions will be given free to the persons sending us a more specific identification.

Gamma-Ray Apparatus and Technique

Emerson's paper provided considerable information on gamma-ray technique. In addition, a comprehensive and detailed investigation of the apparatus used in radium radiography was reported by L. W. Ball of the National Research Laboratories, Ottawa, and D. R. Draper of the Inspection Board, United Kingdom and Canada. This is the paper of which we spoke in such glowing terms on page 83.

For thin material containing fine flaws remote from the film, the source size is most important, while for heavy castings with only coarse cavities the effect of screens and housings in reducing external secondary radiation is a major factor.

In some radiographic situations, a small source is the only way to get sharp images, but in general the effect of source size can be offset by changes in the source-film distance. Secondary effects can be neglected in considering the effect of source size and the relative legibility of narrow images can be established using a simple calculation and data tabulation given in the paper.

The very worst place to use for gamma-ray radiography, from the standpoint of scatter, is a small brick enclosure, although its effects can be somewhat corrected by using a protective lead housing close to the source. Scatter was progressively less objectionable in chambers made of steel, of wood and of lead. Very small rooms are worse, for scatter, than large enclosures.

Designing a suitable cassette for radium radiography is chiefly a matter of deciding the thickness of the lead screens; fluorescent screens can be used only for low-sensitivity work because they are more sensitive to secondary radiation than to primary gamma-rays.

Front and back lead screens should be very thick (something under 0.020 in.) to absorb forward and back scatter. A screen thickness of 0.040 in. has proved to be suitable for general use with thick castings. Where scatter absorption is relatively unimportant, thinner screens are used because of their cheapness and flexibility.

In gamma-ray work with lead intensifying screens, ordinary non-screen film developed for 8 min. at 68 deg. F. in Kodalk

The New STANDARD "INDUSTROMATIC" X-RAY *Apparatus*

A PRODUCTION TOOL For every day inspection of metal from thin aluminum up to 1¾" Steel - - - Almost entirely automatic - - - Operable by unskilled workers

Especially designed for taking fast, accurate radiographs through metal from thin aluminum to 1¾" steel, the "Industromatic" speeds up inspection, saves valuable time. Built for heavy duty, 24-hour-a-day service, this x-ray apparatus *is almost entirely automatic* and *can be operated by any unskilled worker without a knowledge of radiography.* An 8-position Technique Selector switch automatically delivers the correct technical factors—time, kilovoltage and milliamperage, for the particular thickness and type of material to be examined.

Incorporating features never before employed in any x-ray equipment, the "Industromatic" is capable of taking care of 75 to 80% of all industrial work. The model shown above comprises two parts: (1) Automatic Control Panel, and (2) self-contained High Tension Transformer unit which includes a specially designed industrial x-ray tube, two oil immersed valve tubes and a set of copper water cooling coils.

Information regarding—Industrial equipment for x-ray reproduction of templates and pattern—Apparatus for industrial fluoroscopy or visual inspection of metals and alloys—Accessories—will be supplied immediately. Write or wire today.

This powerful 220 Kv Industrial "Flex-Ray" unit produces sharp, clearly detailed radiographs through metal thickness to 2½" steel. Flexible, compact, shockproof.

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developer gives the greatest available speed, contrast and radiographic range. An automatic film agitator is a big help in developing radium-radiographic film, in view of the long developing times and high film densities used.

Other Radiographic Apparatus

The apparatus commonly used for the radiography of light metal castings and forgings was inherited from medical diagnostic radiography, and one of the most unfortunate parts of this inheritance was a cassette design consisting of bakelite, felt, fluorescent screens and a brass frame, stated Ball in still another paper, on cassette design for aircraft castings.

In good cassette design, a rigid frame periphery (to insure close contact between screens and film) of some material like brass or zinc die casting that is opaque to X-rays should be used. The fog from bakelite, for example, reduces the sensitivity at ¼ in. 5 times and at 1 in., twice.

To reduce the forward transmitted scatter from the cassette front, thin sheet metal fronts, without any felt separation, should replace the bakelite frequently employed; sufficient rigidity can be attained by employing a stressed-skin aluminum construction. The front screen also should contain enough absorbing material to act as a filter

With non-screen film, cassette back scatter should be eliminated by a thick back lead screen.

An exposure meter for X-ray radiography was described by H. Friedman & A. L. Christenson of the Naval Research Laboratory. The device consists of a modified Geiger-Müller tube counter, and permits determination of the exposure-time required to reach a given density, after taking a meter reading at a given milliamperage and through a given metal thickness.

Creep of Malleable Cast Iron

An important paper on "Some Creep Studies on Cupola Malleable Cast Iron" was presented by J. J. Kanter and Glen Guarnieri of the metallurgical department of the Crane Co., Chicago. A series of high temperature studies on this material was made. The authors report that this material makes a very creditable showing in relation to the accepted values for silicon-killed carbon steel, having two-thirds of the creep strength of the latter at 800 deg. F.

Excellent stability for malleable iron is indicated by long-time fracture tests at high temperature as well as tension tests at room temperatures on specimens with creep test history. Micrographical studies indicate excellent stability also. Permanent growth incident to creep testing shows little effect until 900 deg. F. is reached.

The authors indicate that "current temperature limitations placed upon the use of malleable iron may be too conservative."

Steel Castings from the Converter

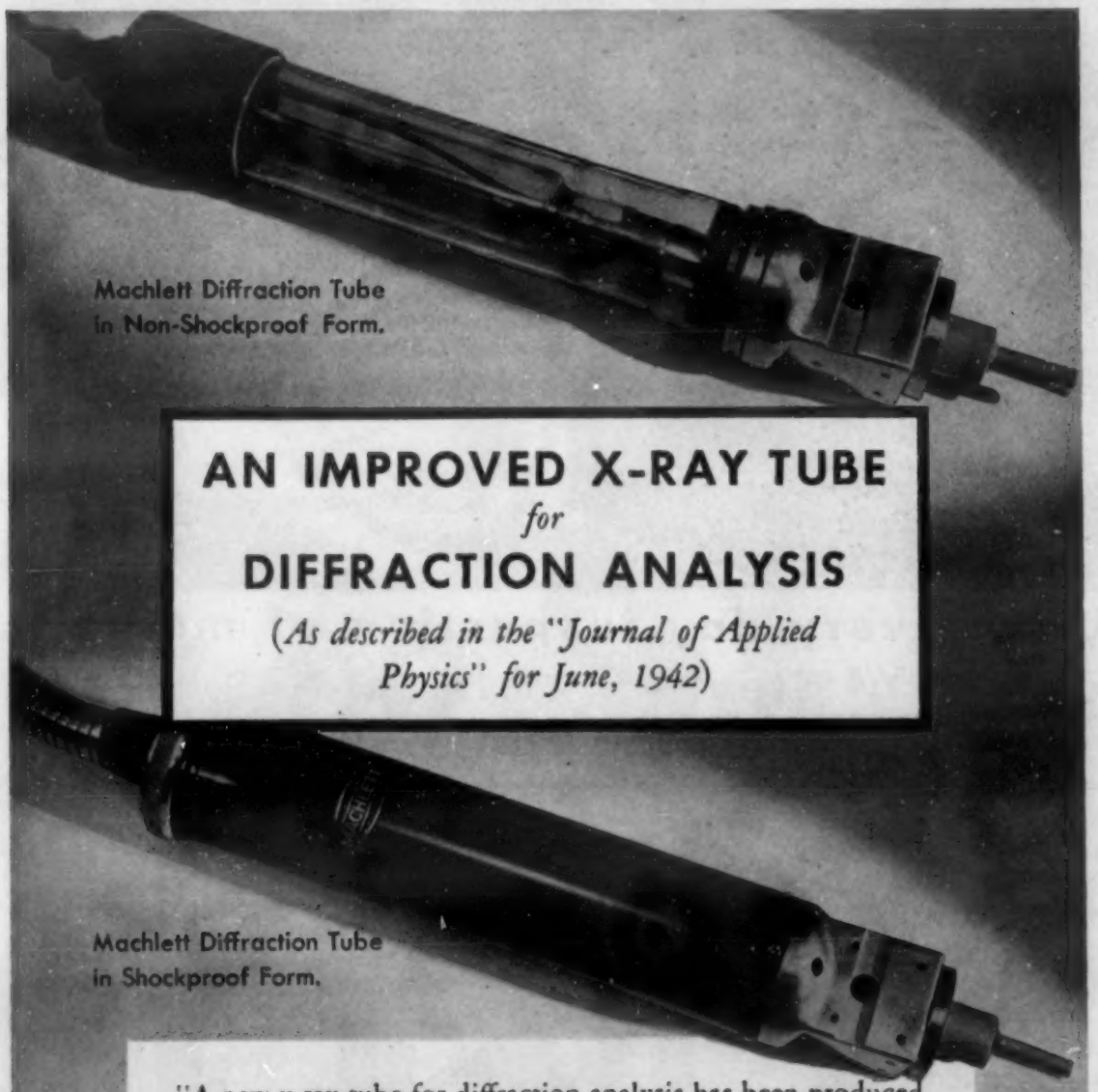
"Comparative Quality of Converter Cast Steel" proved to have been one of the high points among the papers and reports of the session on Steel, Ferro-Alloys, Effect of Temperature. It had been slated in advance to be a focal point of the session and, judging by the interested and spirited discussion afterward, the prediction was fulfilled. The paper was prepared by C. E. Sims and F. B. Dahle, both of the Battelle Memorial Institute, Columbus [an extended abstract of this important paper appears in the feature section of this issue of METALS & ALLOYS].

The subject was timely since so many cast iron foundries find themselves without work, though there is a tremendous demand for steel castings, the equipment to make which exists, particularly as regards cupolas and side blow converters.

The authors conducted tests to determine the engineering properties of grade B converter cast steel in comparison with similar steels made by other melting processes. They conclude that the melting medium is of little moment in determining the properties of cast steel and that the only way to insure any desired property is to specify that property and test for it.

Mechanical or engineering properties of all the steels were governed by composition and by deoxidation, rather than by melting process. With proper deoxidation all processes can make steel of the quality demanded for war purposes, the authors concluded.

In the discussion which followed Arthur Jamison, Malleable Iron Fittings Co., Branford, Conn., stated that this was the first



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"A new x-ray tube for diffraction analysis has been produced which affords much greater x-ray beam intensity than has been possible with previous designs. In addition the purity of the x-ray spectrum is insured. The new tube employs thin sheets of malleable beryllium,* produced by additions of minute amounts of titanium, for windows in the metal tube wall. The low inherent absorption of such windows and their electrical and mechanical sturdiness are factors in the improvement in beam intensity. A shockproof form of the new diffraction analysis tube is also described."

*G. E. Claussen and J. W. Skehan, "Malleable beryllium," Metals and Alloys (April, 1942).

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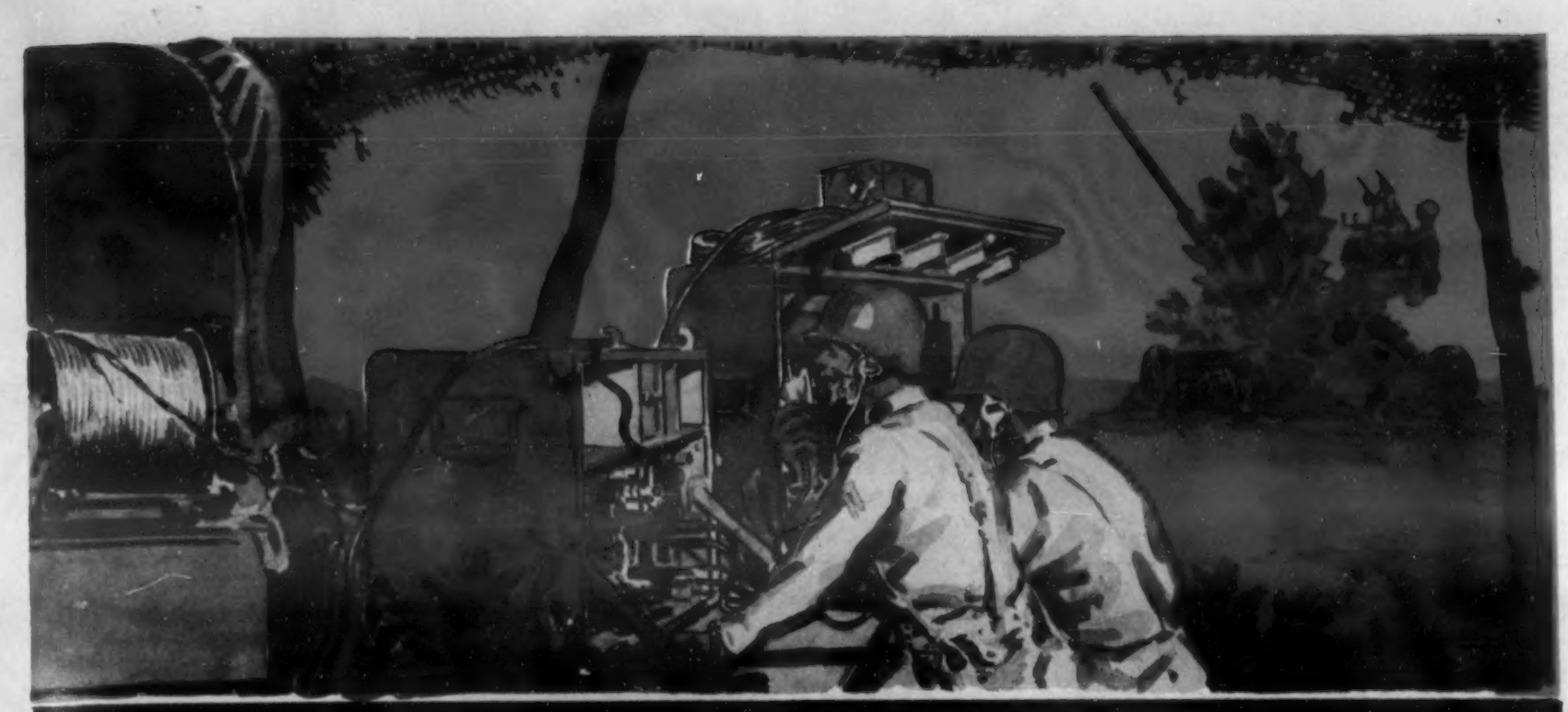

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for testing insulating compounds on signal wire and submarine cable

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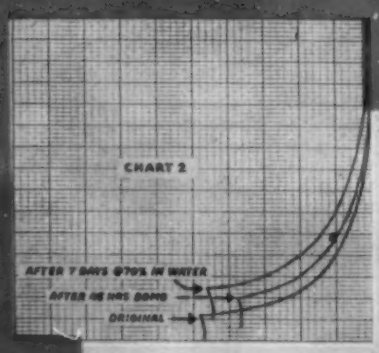
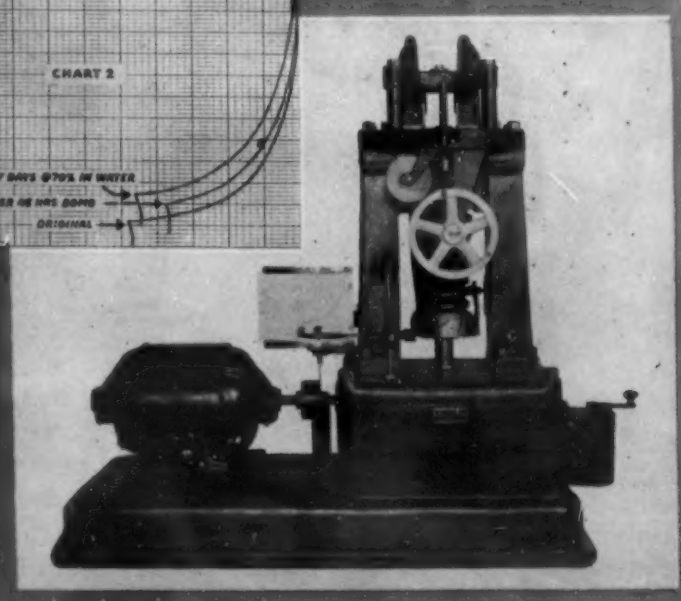
Request "Bulletin R"



Typical "picturized" chart as produced by Model R Compression-cutting tester.



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honest presentation during the 20 years in which we have cast aspersions on this process of casting steel. He stated that opponents never brought any evidence against it in the first place.

John Howe Hall, consulting engineer, Philadelphia, stated that the A.S.T.M. itself was the author of the slur on converter cast steel. He recalled that after a five-year "row" converter steel passed out of the picture. He said that the only change in the process since the first world war was the adding of alkali to control the sulphur.

Testing Electrical Sheet

Eliciting marked interest in the same session was the paper on "Absolute Measurement of the Energy Loss in a Single Strip of Sheet Iron or Steel under Alternating Magnetization," by W. E. Shenk, research engineers, United States Steel Corp., Kearny, N. J.

He described a method and apparatus, developed over eight years, which has proved to be "accurate, sensitive, yet rugged," competing most favorably with the conventional Epstein test method, which requires shearing of samples, this shearing affecting the specimen unfavorably.

This type of tester, the author stated, can be used not only for experimental investigations but as a reliable means of grading electrical sheets. Since the energy loss in sheet steel under alternating magnetization is one of the factors which limits the efficiency of certain electrical machinery, a basic requirement for the intelligent design of such equipment is a fairly precise knowledge of the magnetic quality of the steel to be used.

It was brought out in discussion that the method can test strip as much as 36 in. wide and down to 1 in. in width. One asked if strips in motion (presumably in process of manufacture on continuous mills) could be tested for magnetization, but Dr. Shenk stated that for the present it could not be.

Our Camera Department

Did a lot better this *time, didn't we.* (See page 85)

Incidentally, some of the discussions at the radiography symposium showed that simple cameraddiction never did anyone—even a radiographer—any harm. Someone asked a question about the effect of gamma-rays or X-rays on ordinary photographic film, and a story was told of a stock supply of some of the latest super-duper high-speed photo-film being accidentally placed near some radium during use of the latter overnight, and not being at all fogged as a result.

Alexander Gobus of Lucius Pitkin, on the other hand, was fresh out of X-ray film once, found some Verichrome, gave it double exposure to the radiation and got satisfactory results.

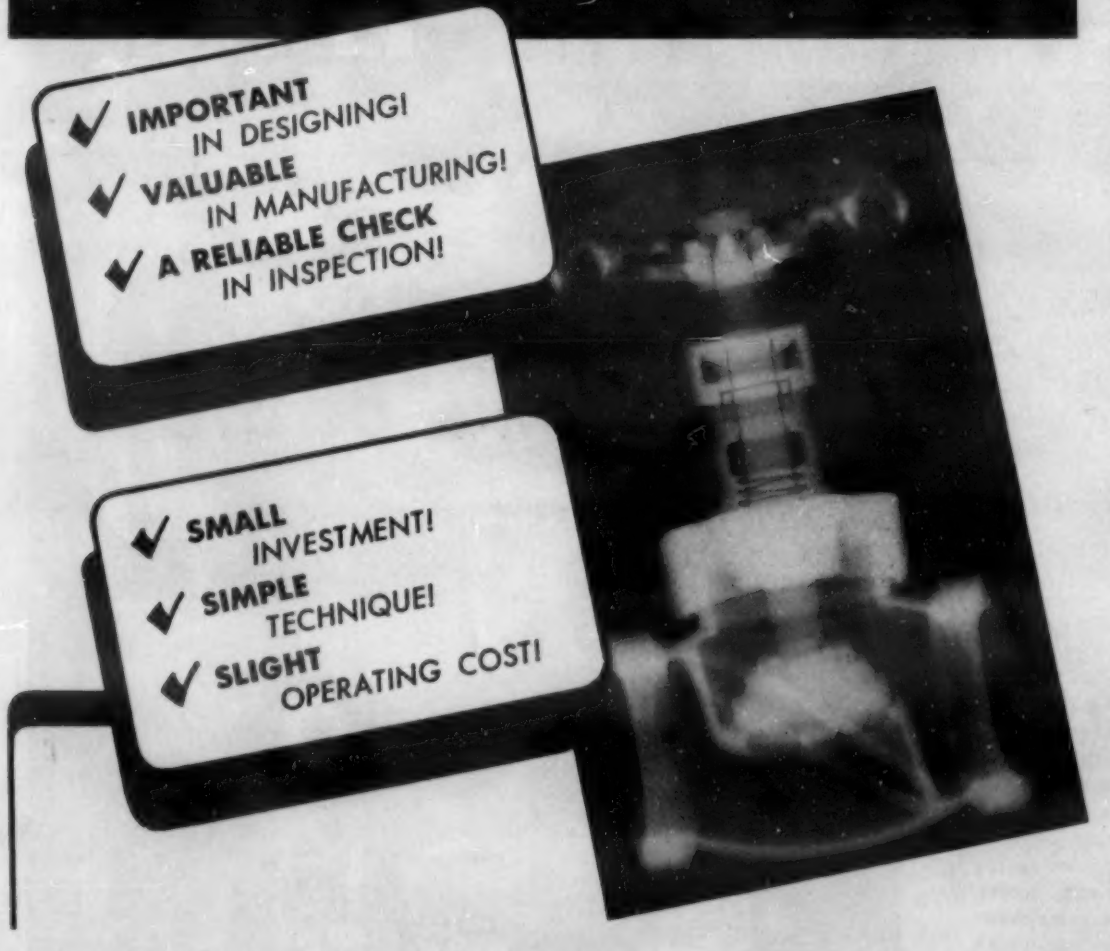
Non-Ferrous Metals

One of the principal papers in the session on non-ferrous metals was that on "Fatigue Testing of Zinc-Base Alloy Die Castings," by E. H. Kelton, research division, New Jersey Zinc Co. Tests had been conducted on die-cast specimens of several such alloys to satisfy the occasional demands for these values. Specimens were subjected to three aging conditions before testing: Six months at room temperature; 6 hr. in 95 deg. C. dry air; and 5 days in 95 deg. C. steam. Testing was done at 25 deg. ±1 C. at a speed of 1600 cycles per min. in a flexure type machine; specimens were usually ¼ in. thick, but sometimes ⅛ in. Results were checked by rotating cantilever-beam tests. Endurance limit was chosen as the greatest stress not causing failure at 100,000,000 cycles.

Curves showed clearly that, for aging condition tested, Zamak-2 (4.1 Al, 2.7 Cu, 0.03 Mg, bal. Zn) in every case had the highest endurance limit and Zamak-3 (4.1 Al, 0.04 Mg, bal. Zn) the lowest, with Zamak-5 (4.10 Al, 1.0 Cu, 0.03 Mg, bal. Zn) in between. Aging treatment of 6 months at room temperature gave the best fatigue properties and the 5-day steam exposure treatment, the poorest. Stabilization for 6 hr. at 95 deg. C. gave intermediate results.

Comparison of rotating beam data with flexure fatigue data showed that the order of endurance limits was the same but that the rotating-beam tests gave somewhat higher values.

Gamma Ray Radiography


✓ IMPORTANT IN DESIGNING!
✓ VALUABLE IN MANUFACTURING!
✓ A RELIABLE CHECK IN INSPECTION!
✓ SMALL INVESTMENT!
✓ SIMPLE TECHNIQUE!
✓ SLIGHT OPERATING COST!

Gamma-Ray Radiography is the modern answer to today's imperative necessity for sounder metal structure . . . Radiography gives the metallurgist and engineer a clear *inside* picture of metal quality—of the absence or presence of defects, cracks, voids, non-metallic inclusions, or imperfectly fused portions of welds.

The initial investment in radium is relatively little; operating cost is negligible. The technique is simple and safe — there is no loss, no maintenance cost.

Write for your copy of the new publication "Manual of Industrial Gamma-Ray Radiography."

Specialists IN INDUSTRIAL RADIOGRAPHY

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EVERY DAY THAT THE VALUE OF TESTING DEPENDS ON THE QUALITY OF THE TESTING EQUIPMENT..

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UNIVERSAL TESTING MACHINES

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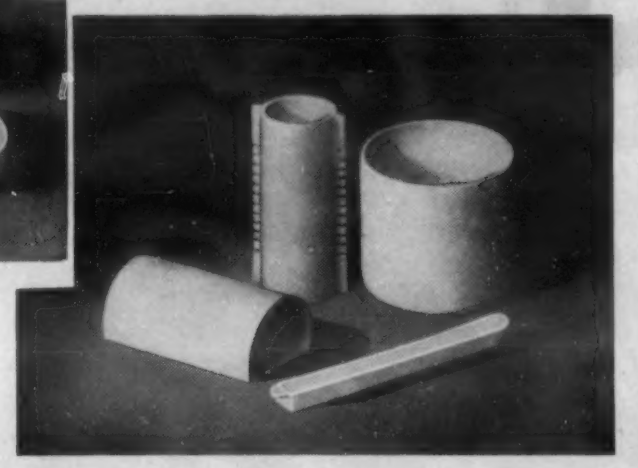
RE-CRYSTALLIZED ALUMINA

Vessels and Tubes of Special Advantage for the Fusion of Many Metals



THERMAL ALUMINA WARE, in the form of combustion boats, crucibles, tubes and other industrial pieces is finding increasing usefulness in metallurgical laboratories for the fusion of a number of metals . . . Composed of pure re-crystallized alumina, this new ware is suitable for working temperatures up to 1950°C. and may be wound directly for electrical heating.

Thermal Alumina Ware is unaffected by reducing gases at high temperatures and its high purity (99.9% Al_2O_3) indicates its particular usefulness in applications where a pure resultant product—free from contamination by the containing vessel—is of paramount importance.

Thermal Alumina laboratory vessels are obtainable direct from the manufacturer or through dealers in laboratory supplies.

Write for Bulletin #6

THE THERMAL SYNDICATE, LTD.

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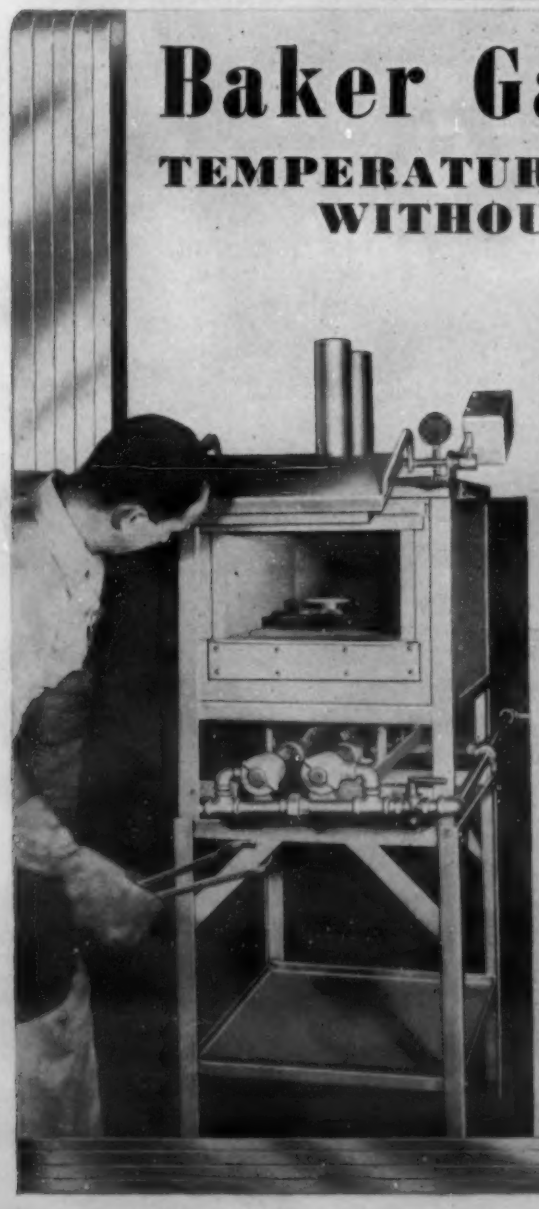


Baker Gas Furnaces

TEMPERATURES UP TO 2400° F. WITHOUT A BLOWER

BAKER Blowerless Gas Furnaces are very low in gas consumption, noiseless in operation, reach the required temperature rapidly and are equipped with thermocouple and accurate pyrometer. The research departments of some of the largest corporations have contributed to making their high efficiency possible.

There are 9 standard stock models ranging in size from No. 1 (Bench type), which is 6" x 8" x 5½", to No. 24, which is 12" x 20" x 8" as illustrated. All provide uniform, controlled heat up to 1900° F.

Model No. 5, 6" x 12" x 5", is built especially for treating high speed steel. Gives uniform, controlled temperatures up to 2400° F.

We stock one Hydrogen Atmosphere furnace, No. 12, with a closed muffle 8½" x 15" x 2½" high.

Special size furnaces built to your order. Write for descriptive folder and prices.

BAKER & CO., INC.

113 Astor St., Newark, N. J.

In the discussion G. W. Stickley, Aluminum Co. of America, suggested that fatigue strength in such die castings depends on design more than it does on materials.

Here and There

The annual 1943 spring meeting of committees of the Society is tentatively scheduled for March in Buffalo—"if, as and when."

Representatives of other technical societies were noted as present—Secretary Kennedy and technical secretary Hindle of the A.F.A., assistant secretary Bayless of the A.S.M., and metals-divisions secretary Sisco of the A.I.M.E.

A prominent authority on impact testing told us that he regarded as a very important trend the probable writing of specifications for notch impact testing of material for use at sub-zero temperatures.

Many of us have been looking forward for some time to the published data of one of the sub-committees of A-10 covering the physical, chemical and mechanical properties of the iron-chromium, iron-chromium-nickel and related alloys. Announcement is made that the data covering wrought products will be available as a pamphlet inside of two months. This is a highly important matter.

There are decidedly favorable signs that the side blow converter will again take its place in the specifications as an accepted process (now banned) for steel castings for high temperature and other service. Orders for 51 are reported since Jan. 1, 1941.

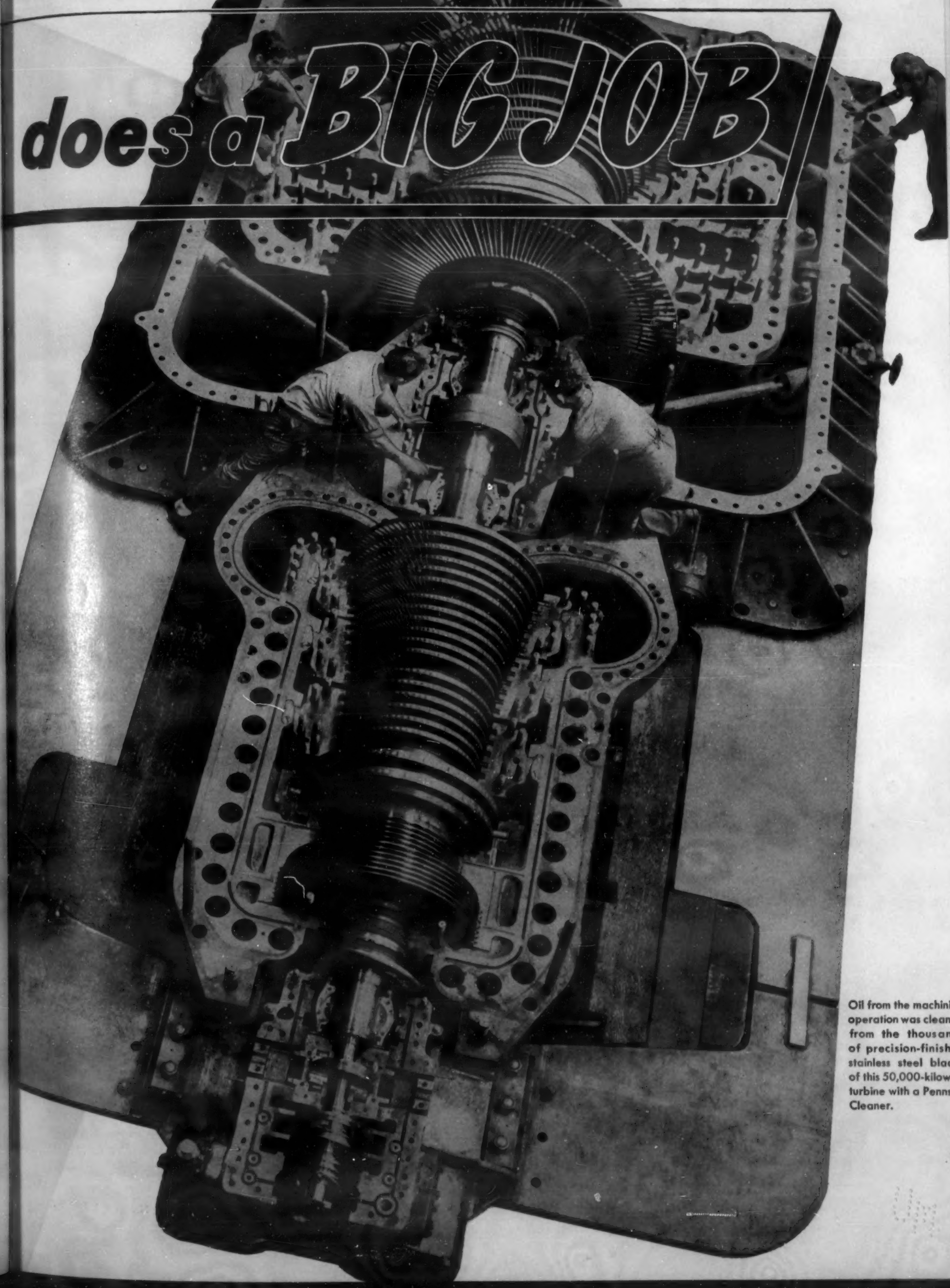
The very excellent annual address of the Society's president was suddenly interrupted. As President Lundell was half way through his address before a large attendance a member close to the front collapsed. In the course of a half hour he was revived and able to leave the hall.

A forceful speech, indeed!

While this year's attendance did not measure up to that of the 1941 convention in Chicago, it was close to that of 1940 at Atlantic City—over 1,300.

What looks like an extremely promising development in the field of ultra-high-power microscopy is the new scanning electron microscope described by V. K. Zworykin, J. Hillier & R. L. Snyder of RCA Mfg. Co. The new instrument, whose electronic principle is similar to that of television or facsimile reproduction, has a great metallographic advantage over the "standard" electron microscope in that it can observe the surfaces of opaque objects directly. Magnification of several thousand times, with a resolution as fine as 500 A.U., are features of the scanning electron microscope.

does a BIG JOB



Oil from the machining operation was cleaned from the thousands of precision-finished stainless steel blades of this 50,000-kilowatt turbine with a Pennsalt Cleaner.

Standard Carbide Tools Tailored To Many Shapes

A tool engineer with "Yankee ingenuity" saved himself and his company weeks of time and considerable cash by ordering a supply of standard carbide tools, which he could get on immediate delivery, and grinding them to over 200 various special shapes needed for chamfering, grooving, forming operations, etc.

These special carbide cutting tools, made by *Carboloy Co., Inc.,* Detroit, with their square ends, looked alike as "two peas in a pod." The accompanying photograph

shows how a certain "destiny shaped their ends" into 24 styles, with 176 more not showing in the picture.

● A liquid soldering flux, said to be so powerful it will easily solder stainless steels, Monel metal, alloy coppers, brasses, iron, zinc and practically every metal and alloy except aluminum, is special X industrial concentrate, made by *Industrial Service Laboratories,* 7656 W. Forest Home Ave., Milwaukee. It is being used to fabricate divers' helmets, submarine controls, machine gun parts, chemical tanks, etc. It will not injure or discolor the base metal.

Pull that rip cord! the grip won't fail . . it's brazed with EASY-FLO

Acme photo courtesy U. S. Navy

Upper view shows parts ready for brazing. Note the preplaced rings of EASY-FLO wire on the side piece—a method that speeds up production and gives accurate control of amount of alloy. In brazing the arch EASY-FLO is hand fed. Lower view shows the finished and plated grip—strong as a solid piece.

Rip cord grips, so vital to successful military operations and safety, are made largely of steel, stainless steel or Monel tubing. Their construction is shown to the left. The responsible job of joining these parts into one reliable whole is entrusted to EASY-FLO.

This is easy to understand because EASY-FLO is a known quantity. In its peace time uses, EASY-FLO proved that it consistently made strong, permanently reliable joints. That's the important reason why this low-temperature silver brazing alloy today is being used on hundreds of jobs associated with the making of planes, ships, tanks, guns, shells and other materials of war. Another big reason is speed — EASY-FLO is the fastest acting of all brazing alloys.

GET EASY-FLO DETAILS IN BULLETIN No. 12

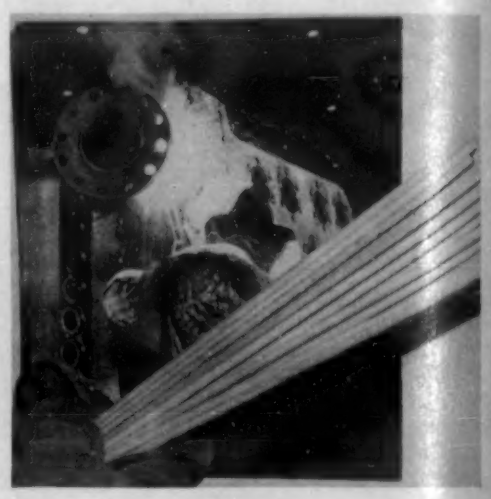
This bulletin gives you the facts about EASY-FLO — explains why it is so fast and so reliable — tells you how to put it to work in your plant — also contains much valuable information about joint designs, heating methods, production-boosting procedures. Write for a copy today.

HANDY & HARMAN 82 FULTON ST., NEW YORK

Agents in Principal Cities. In Canada: HANDY & HARMAN of Canada, Ltd., Toronto

Versatile A-C Welding Electrode

An all-position alternating-current electrode adaptable to both vertical and overhead positions has been sponsored by *General Electric Co.,* Schenectady. This electrode, Type W-26, allows welding shops



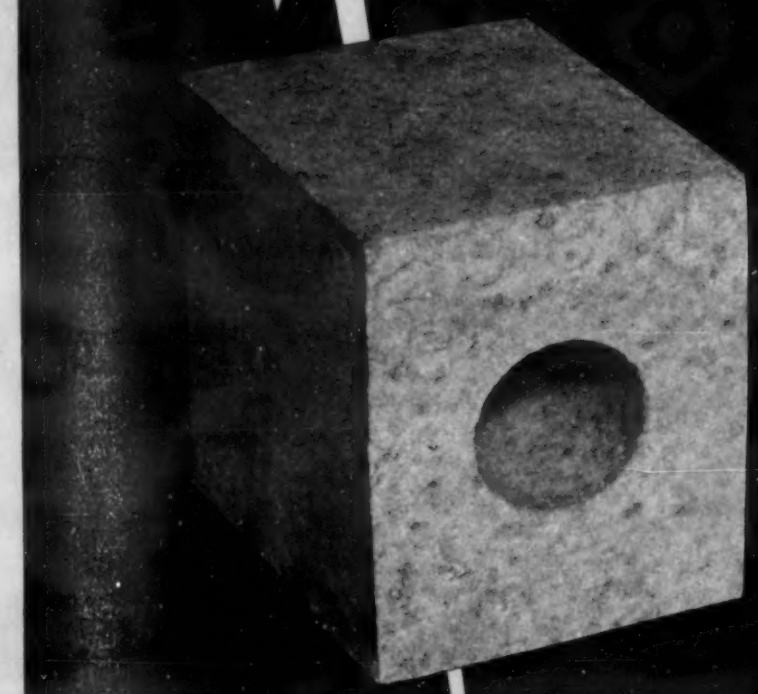
and fabricators, who have previously had to supplement their a-c welders with standby d-c welders for high-quality work in the vertical and overhead positions, to release these machines for fabrication work where d-c welding may be essential.

Alternating-current had already demonstrated its advantages for work in the horizontal and flat positions. Type W-26 complies with three standard codes and specifications, including A.S.M.E. Boiler Code, Para. U 68. It produces a strong, forceful arc having good fusion, excellent penetration and uniform characteristics, free from arc blow. It is now available in 1/8 and 5/32 in. diameters; sizes from 1/16 to 1/4 in. will be available soon.

● A pitch of improved plastic characteristics for weatherproofing prefabricated metal and shapes, called "Plastipitch," is produced by *Coated Products Corp.,* Verona, Pa. It is said to be adaptable to all types of metals of various sizes, shapes, forms or gages. The coating will not become brittle or chip off at low temperatures, nor melt or flow at high atmospheric temperatures.

(More news on page 104)

NORTON Burner Blocks Reduce "Down Time"



Subjected to terrific temperatures and severe heat shocks the burner blocks in large billet heating furnaces soon failed. Frequent "down time" for replacing the blocks cut down plant production, which is 100% war work. Norton engineers provided a specially designed *Alundum* cement and worked out a special ramming technique. Result: burner blocks that fulfill the severe requirements and give long trouble-free service.

* * * *

Norton engineers work with the most refractory substances known: *Alundum* (Al_2O_3), *Crystolon* (SiC) and fused Magnesia grains. They are constantly developing better mixes to meet the requirements of industry at war tempo. Their research results in refractories tailored to your needs.

R-725

NORTON COMPANY

Worcester, Massachusetts

Engineered for each job

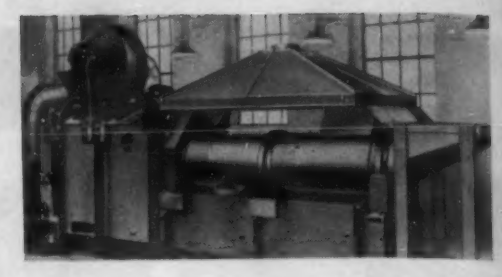
NORTON ELECTRIC FURNACE FUSED REFRACTORIES

● An aluminum cleaner, designed to save time and increase the safety of handling aluminum in alkali cleaners, was developed by Claudius Nielsen in cooperation with the Willow Run Bomber plant where short cuts are being developed. It is known as "Nielco Lab. 1167," made by *Nielco Laboratories,* 19720 Florence Road, Detroit. It rapidly cleans a sheet of aluminum to a perfect water-shed and without building up an oxide coating. It has proved effective in removal of oil and zinc chromate and lacquer.

Metal Parts Cleaning Equipment

For cleaning small metal parts a three-operation revolving drum Colt Autosan has been brought out by the *Colt's Patent Fire Arms Mfg. Co.,* Hartford, Conn. Model 282, depicted here, is one of a line of machines, from small compact, single-purpose units to large, powerful, multi-purpose machines, handling small parts up to large castings.

Model 282 washes, rinses and dries—some models lubricate in addition. Parts

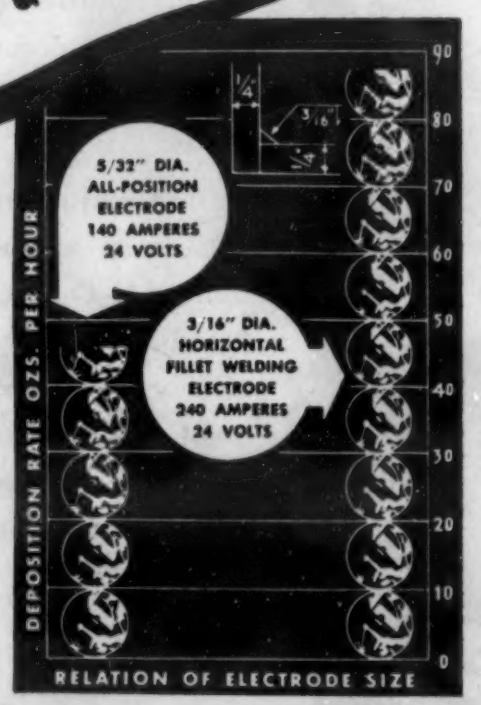


placed in a hopper are fed in controlled amounts into the revolving chamber through which they are propelled by a built-in spiral. Parts are washed, then rinsed, being agitated and rolled over and over.

Leaving the rinse section, parts pass through the drying cylinders where the rolling agitation continues, a forced blast of heated air removing all moisture. Several types of hoppers give choice of 3-15 cu. ft. capacity. Production capacity of Model 282 varies from 20 to 75 cu. ft. per hr.

● A new record for production of shell forgings on a single manufacturing line has been made by *National Supply Co.,* Pittsburgh, according to F. G. Schranz, divisional vice president of the Baldwin Southwark Div., Baldwin Locomotive Works, whose presses were used. One crew, in an 8-hr. shift, made 2,277 artillery shell forgings on one unit, consisting of two piercing presses and one drawing press. No forgings were rejected by ordnance inspectors.

HOW LARGER SIZES OF ELECTRODES CAN INCREASE YOUR WELDING PRODUCTION



You can speed up fabrication in your welding shop immeasurably by using the largest sizes of rods that are practical for their applications, as, under normal conditions and when proper currents are used, the greater the electrode diameter the higher is the resulting deposition rate.

The accompanying table shows the application of this principle to the making of a 3/16" fillet weld in ¼" plate. The 5/32" diameter all-position electrode has a deposition rate of only 46 ounces per hour. Should it be possible to use a 3/16" diameter mineral coated rod, designed for horizontal fillet welding, which operates at high currents and permits a very fast rate of travel, the deposition rate jumps to 87 ounces per hour.

By specifying the larger sizes and using the all-mineral type coatings wherever possible, you will also enable us to increase *our* production and help relieve the electrode shortage, as we can manufacture these types much more quickly than the smaller diameters and other types of coated rods.

Murex engineers are available for consultation to manufacturers who are directly or indirectly engaged in war production—whether or not they are users of Murex electrodes.

Specialists in welding for nearly 40 years. Manufacturers of Murex Electrodes for arc welding and of Thermit for repair and fabrication of heavy parts.

MUREX
ARC WELDING ELECTRODES

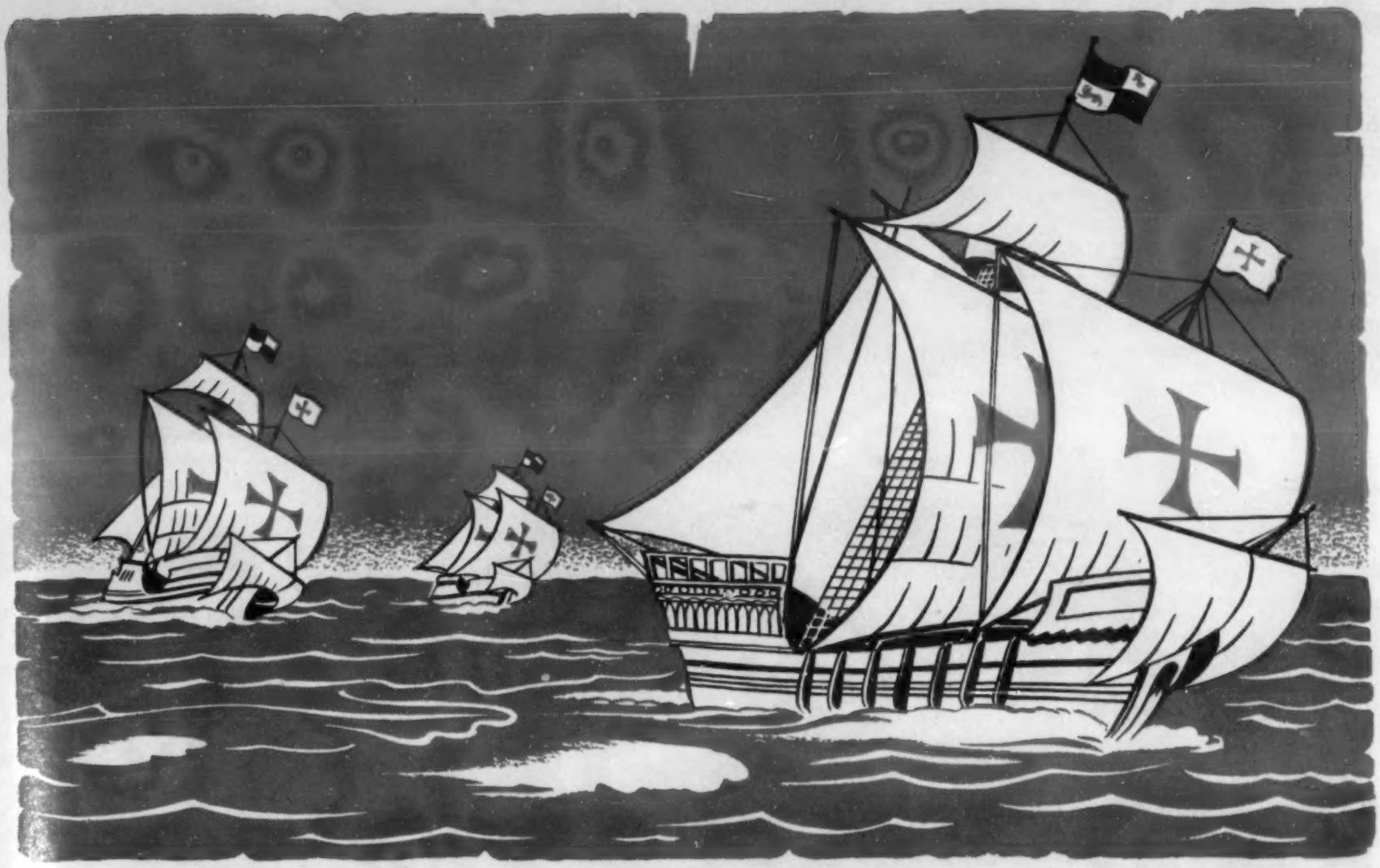
METAL & THERMIT CORP.
120 BROADWAY • NEW YORK, N. Y.
Albany • Chicago • Pittsburgh • S. San Francisco • Toronto

Morale Builders

"Musical pep cocktails" are served at The Westinghouse Lamp Div., Bloomfield, N. J., which is one of 500 industrial plants among the United Nations to use this stimulant for production. Marches, tangos and swing for five and a half hours per day come over loudspeakers. Band music sets the pace for the day as workers assemble for the first shift at 7 a.m. Viennese waltzes are preferred to the ordinary waltzes, having a faster tempo and hence stimulating faster work movements. Reminds us of the farmer who found the hired men swinging their scythes to the rhythm of the food they had for breakfeast: Pork chops and gravy. He switched to ham and eggs.

The "Duration Club" is an exclusive organization of the Rome Mfg. Co., Rome, N. Y., division of Revere Copper & Brass, Inc. Members are former "pavement pounders" who sold pots, pans, skillets, ashtrays and giftware in balmier days. Thirteen of the club recently sat down to dinner. One is now a factory timekeeper; another has a factory office job; a third is a payroll clerk—all in new jobs for them in essential war work. Their "Duration Club" keeps alive their salesmen's traditions; keeps the flow of traveling salesmen's stories normal; and tides them over the grim days until they can renew their beats on the hot pavements.

(More news on page 106)



The Days of Exploration are not Past

COLUMBUS could not have imagined that the New World he discovered would twice be called on to save his Old World from itself. Nor could he have had an inkling of our immense resources with which we built a dominating iron and steel industry providing the sinews of war and peace.

MALLEABLE

The founders of Belle City Malleable Iron Co. in 1892, four hundred years after Columbus, launched forth into a fifty year era of exploration and development in ferrous castings. Malleable iron grew from a substitute for wrought iron to an essential metal for mobile equipment.

STEEL

In the late 90's steel castings came into use and received a big boost with the electric melting furnace, one of the first of which in the Middle West was bought in 1916 for our new division, Racine Steel Castings Co.

BELECTRIC

Since the last war the development of gray iron as an engineering material has been far-reaching. *Belectric* Iron, electric furnace melted and graded from 35,000 to 65,000 lbs. tensile strength, is a specification iron cast to meet specified physical properties within close limits.

BELMALLOY

Exploring the possibilities of electric furnace melting and continuous kiln annealing, we brought out in 1935 *Belmalloy*, a pearlitic malleable, and *Belectromal*, a high strength malleable. These metals fit into the space between malleable and steel castings and relieve the pressure on steel castings or forgings for war production.

Send for our 50th Anniversary Booklet giving the story of ferrous castings. Examine your design and production set-up to see if you can use castings of our special metals for less readily obtainable materials.

BELLE CITY MALLEABLE IRON CO.

RACINE STEEL CASTINGS CO.

Racine Wisconsin

News of Metallurgical Engineers

W. J. Reagan, formerly open-hearth superintendent of the Edgewater Steel Co., has joined the metallurgical engineering staff of the Copperweld Steel Co., Warren, Ohio.

Alfred Sontag, for ten years chief engineer and sales manager, Riehle Testing Machine Div., American Machine & Metals Co., has joined the staff of the testing machine department, Baldwin Southwark Div., Baldwin Locomotive Works, Philadelphia.

John D. Dale has been granted a leave of absence by the directors of Charles Hardy, Inc., New York, to enter the army. Mr. Dale will retain his position as vice-president and director of the company, pending his return from service.

John W. Sands, formerly metallurgist, International Nickel Co., New York, has become consultant for the Bureau of Industrial Conservation, W.P.B., Washington.

James F. Ednie has been named chief metallurgist, technical and metallurgical department, Duquesne Smelting Corp., Pittsburgh, having been with the metallurgical and research department, Federated Metals Div., American Smelting & Refining Co.

Sydney Nasliner, formerly metallurgist, Inland Steel Co., Indiana Harbor, Ind., has become first lieutenant, Production Div., Pine Bluff Arsenal, Pine Bluff, Ark.

L. D. Orr has left Western Electric Co., Chicago, to be metallurgist for Nash-Kelvinator Corp., Propeller Div., Lansing, Mich.

H. A. Moorhead has been named metallurgical engineer, Carnegie-Illinois Steel Corp., Chicago, bar and semi-finished products.

Walter S. Gips has been made metallurgical engineer and consultant, operating department, N. Rhodiman Oxygen & Acetylene Co., N'Dola, N. Rhodesia, Africa.

L. E. Grant, metallurgist and welding engineer, has been promoted to engineer of tests, Chicago, Milwaukee, St. Paul & Pacific Railroad.

Frederick Laist has been elected vice president in charge of metallurgical operations, Anaconda Copper Mining Co., New York, having been general metallurgical manager, same company.

Harold Cope has been named division metallurgist at Cleveland, for the American Steel & Wire Co., having been assistant general superintendent at Donora, Pa.

Dr. Reginald S. Dean, chief, metallurgical division, Bureau of Mines, has been appointed assistant director of the Bureau. In recent years Dr. Dean has concentrated on the development of methods and processes for treating and beneficiating domestic minerals. He was responsible for the new metallurgical material, high-purity electrolytic manganese, as well as improving processes for recovering native antimony, nickel, cobalt, titanium and boron. After graduating from the Missouri School of Mines, and attending the University of Chicago, Harvard, and the University of Maryland, he was with the metallurgical departments of the American Zinc, Lead & Smelting Co. and the Anaconda Copper Mining Co.

Charles A. Mabey has become director of the research activities of the Bristol Co., Waterbury, Conn., maker of industrial process instruments and automatic control apparatus. He had served as physicist with that organization for years, and has been with International Communications Laboratories, New York, Federal Telegraph Co., Newark, N. J., and Mathieson Alkali Works, New York. He was graduated from Harvard and has attended Massachusetts Institute of Technology.

(More news on page 108)

Built RIGHT!

with AMPCO Bronzes' Rugged Strength

Designing engineers—men who know materials—find need for Ampco Metal and Ampco-made bronzes in the vital instruments of war. In anti-aircraft gun mounts—in aircraft—in machine tools—bronzes from the Ampco foundries are in service.

TO GOVERNMENT SPECIFICATIONS

Much of the bronze cast at Ampco is to government specification. The wide experience of our engineers and metallurgists—skilled in producing bronzes to meet exacting conditions—is at the service of government contractors and others supplying essential equipment.

If you need a bronze that must meet definite physical properties and chemical composition, consult with Ampco. All alloys are laboratory controlled and closely inspected at every step with precision instruments. *Ask for literature.*

AMPCO METAL, INC.

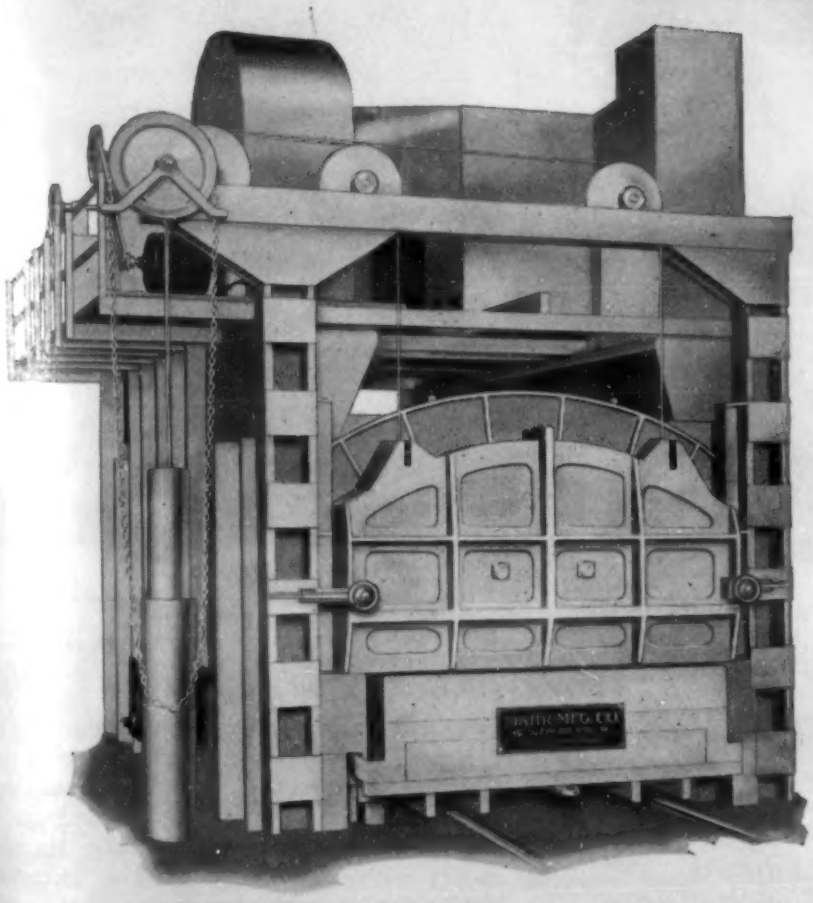
DEPARTMENT MA-7 MILWAUKEE, WISCONSIN

AMPCO METAL

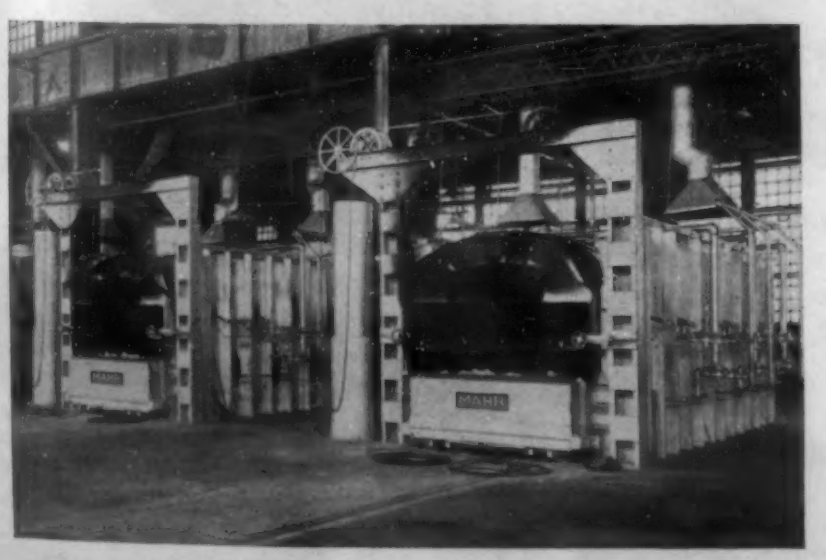
AMPCO

THE METAL WITHOUT AN EQUAL

HOW DO TANKS GET THAT WAY?



MAHR recirculating air draw-stress relief furnace.



MAHR car bottom Carburizing furnaces for Carburizing armor plate.

COLOSSUS OF TODAY'S BATTLEFRONT—Behemoth of ruggedness and well-nigh irresistable power—precision motored, ultra offensive—yet, like the ponderous tortoise, dependent upon its *shell* for protection from enemy assault!

American tank manufacturers today are using many MAHR Carburizing and air draw-stress relief furnaces for perfecting the super armor of modern tanks. MAHR continuous, car and batch type furnaces are also used extensively for the critical heat treatment of tank transmissions to give them dependable, rugged driving power. That's because, through the years, MAHR furnaces have always been on the front line of heat treating progress in *every* phase!

FOR EVERY HEAT TREATING NEED

ANNEALING, CARBURIZING, BAKING, HARDENING, FORGING, DRAWING, STRESS RELIEF—CAR BOTTOM, PIT, PUSHER, ROLLER HEARTH, CONTINUOUS, POT . . . RIVET FORGES, TORCHES, BURNERS, BLOWERS, VALVES.

WRITE, WIRE OR PHONE TODAY

Our engineers will gladly help you select the type unit you need, and we'll give you complete information on any specific request. There's an engineer-representative near you for quick consultation.

MAHR MANUFACTURING CO.

DIV. DIAMOND IRON WORKS, INC.

GENERAL OFFICES—MINNEAPOLIS, MINN.
SALES OFFICES IN PRINCIPAL CITIES

125,000 Metallurgical Man Years

The Metals and Minerals Advisory Committee of the National Academy of Sciences has furnished OPM and WPB with 113 reports bearing on our war effort during the past 18 months, states Frank B. Jewett, president of the academy. Fifty-three of the reports were on metals substitution and conservation, 47 on ferrous minerals and ferro-alloys, 4 on tin smelting and reclamation, and 9 on non-metallic minerals.

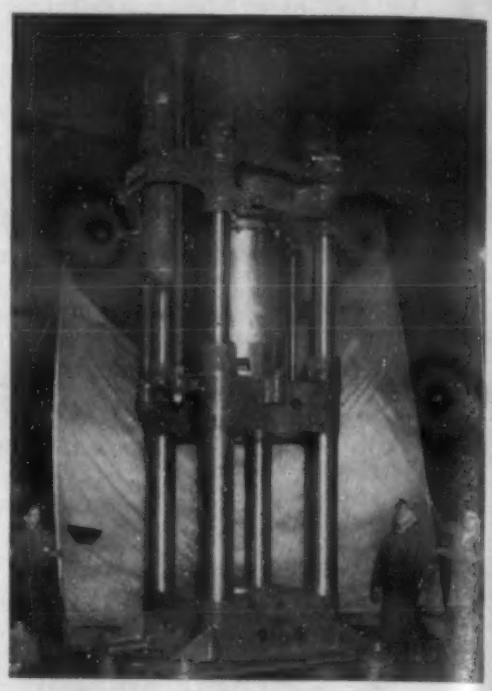
This committee makes available for the Army and Navy the services of any or all metallurgical research, personnel and facilities. There are over 10,000 such individuals in the country, their combined experience being over 125,000 man years.

The committee digests and makes available the results of Canadian and English metallurgical research. Typical of the problems referred to the committee is one asking for improvement in welding processes. WPB has asked information on the effect of substitution of lead-silver for tin-lead soldering of tin cans used for food products.

Allied with the movement is the new War Metallurgy Committee, composed of 26 members, headed by Clyde Williams, director Battelle Memorial Institute, Columbus.

Piercing Press for Shell Forgings

A new 500-ton piercing press for shell forging plants has been produced by the *Baldwin Southwark Div., Baldwin Locomotive Works,* Philadelphia. The main ram



is 32 in. in diameter, stroke of 42 in., with working pressure of 1,500 lbs. Distance between platens is 99 in., the stripper cylinder in the bottom platen having a 12-in. diam. Overall height is 25 ft., 3½ in.

The press is of all cast steel; rams are hard cast iron; cylinder and column guides are bronze bushed. Press columns are designed to withstand 240 strokes per hr. on a 24-hr. day operation.

● Two new lead-base bearing metals, Pyramid and Defender, have been developed by the *Magnolia Metal Co.,* 120 Bayway, Elizabeth, N. J., as substitutes for tin-base babbitts. Pyramid is good for heavy sustained pressures such as in marine reciprocating engines, water turbines and rolling mill machinery. Defender stands shocks without cracking, good in internal combustion engines, trap rock crushers and sifter machinery.

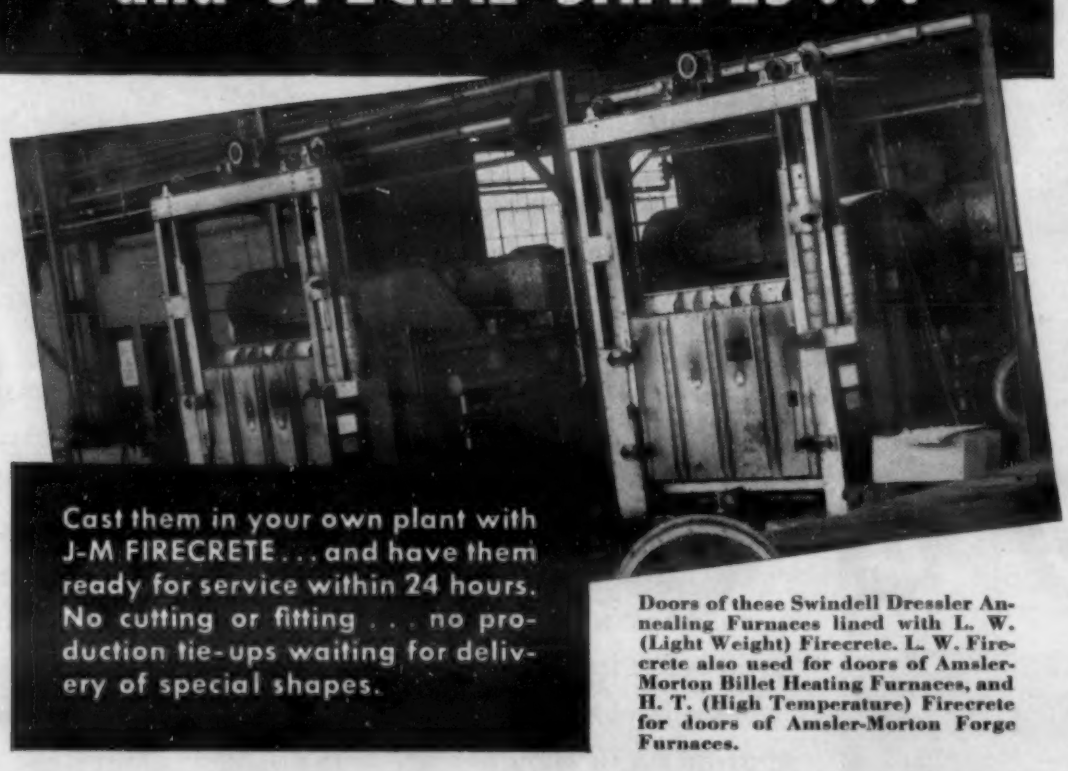
Silver in Stainless Steel

The correct addition of silver in stainless steel decreases pit corrosion, gives a better surface polish, lends corrosion-resistance and improves machining properties, states the *American Silver Producers' Research Project,* 82 Fulton St., New York.

An effective means of introducing the silver is an alloy containing 4 per cent silver, a master alloy which results in a uniform distribution, more so than when silver is used by itself. Proportion of silver is about 1 per cent when nickel is high, or up to 2 per cent when manganese is high. Less work-hardening of stainless-steel results when silver is employed thus.

(More news on page 110)

END DELAY on DOOR LININGS and SPECIAL SHAPES . . .



Cast them in your own plant with J-M FIRECRETE . . . and have them ready for service within 24 hours. No cutting or fitting . . . no production tie-ups waiting for delivery of special shapes.

Doors of these Swindell Dressler Annealing Furnaces lined with L. W. (Light Weight) Firecrete. L. W. Firecrete also used for doors of Amsler-Morton Billet Heating Furnaces, and H. T. (High Temperature) Firecrete for doors of Amsler-Morton Forge Furnaces.

Yes, Firecrete is a great time-saver in these days when speed is so vital. But Firecrete is also just about the best refractory you could possibly use from a performance standpoint. It has practically no drying or firing shrinkage and is highly resistant to spalling. It's used for furnace doors and linings, baffle tile, burner rings, pipe linings and special shapes. Four types available:

For temperatures up to 2400° F.— Standard Firecrete.

For temperatures up to 2200° F.— L. W. (Light Weight) Firecrete.

For temperatures up to 2800° F.— H. T. (High Temperature) Firecrete.

For temperatures up to 3200° F.— J-M Chrome Castable. Designed particularly for use in forging and heat-treating furnace bottoms.

• • •

FIRECRETE is shipped in 100-lb. bags. And it is readily available. For details and prices, write Johns-Manville, 22 East 40th Street, New York, N. Y.

Johns-Manville

FIRECRETE CASTABLE REFRACTORIES

P. A. system speeds blast-furnace control

Something new has been added to the desk of our blast-furnace superintendent at Bethlehem—a microphone.

Now, in less than two minutes, the super can talk not only to *any* man in his department, but to *every* one of his 175 helpers on a given shift. There's a powerful loudspeaker and a microphone in every key location in the string of furnaces, engine houses, power stations and hot stoves which make up the blast furnace division of the plant.

Control of every phase of operation is tightened up by the new P. A. system. Precious minutes are saved—and when you're running a string of blast-furnaces, minutes . . . even seconds . . . count big.

Instant communication between all parts of the blast-furnace department—which incidentally would be invaluable in an emergency—is saving thousands of dollars' worth of blast-furnace gas by rerouting it quickly to soaking pits, engine houses, heat-treating furnaces, or other units where it can be put to work. And, through closer control of operations, the Public Address system is helping to produce more and better pig iron, at a time when pig iron is vitally needed.

Right now, every pound of iron Bethlehem makes is of course being allocated to war production. But after the war, when trade once again flows through peacetime channels, such advances in production methods as this new rapid system of communication, applied under war conditions, will help Bethlehem better to serve its customers in every field of industry.

BETHLEHEM STEEL COMPANY

BETHLEHEM STEEL

● To meet faster cycles in anodic degreasing or reverse current cleaning of cold-rolled steel parts before finishing, a new alkaline-type material, Oakite Composition No. 90, has been developed by *Oakite Products, Inc.*, 32H Thames St., New York. It is being used on gun mechanisms, control instruments, aircraft forgings and bearings, etc. It is adapted also to plating departments and contract finishing shops using the Bullard-Dunn process for tin coating of steel.

Slants and Plants

Armed with buckets, both white collar workers and those in overalls of the *Shell Oil Co.* scour the countryside far and wide, as well as the plant premises, for scrap metal. By June 1st they had collected so far this year 6,000 tons of metal, including iron, lead, tin, copper and zinc. Nails and bits of wire are collected—nothing is too small.

A jeweled service pin of gold was presented to each of the 50 men and women of the *Foxboro Co.*, Foxboro, Mass., instruments for process measurement and control, who had completed 25 years or more in its service.

The New Detroit plant of the *Jansson Gage Co.* was scheduled for opening June 15th. The 3,500-ft. building is to be devoted exclusively to the manufacture of precision block and thread gages for war production. An improved temperature room keeps the reading at 68 deg. F.

Because of increased demands for materials produced by power metallurgy, the *Keystone Carbon Co.*, St. Marys, Pa., has completed a large program of expansion. The company produces precision molded products.

The *Ergolyte Mfg. Co.*, maker of a.c. electric arc welders, has opened a new plant at 3627-31 N. Lawrence St., Philadelphia, which is over twice the size of the previous plant.

Two large continuous slab and billet reheating furnaces are being constructed for *Bethlehem Steel Co.* by the *Rust Furnace Co.*, Pittsburgh, to be installed on the West Coast and in Maryland. Contracts are in excess of $1,000,000.

Seaboard Engineering Co. has opened an office at 29 Church St., Paterson, N. J., to do general industrial engineering, specializing on tool and machine design, under the management of G. J. Zwicher, vice president and general manager.

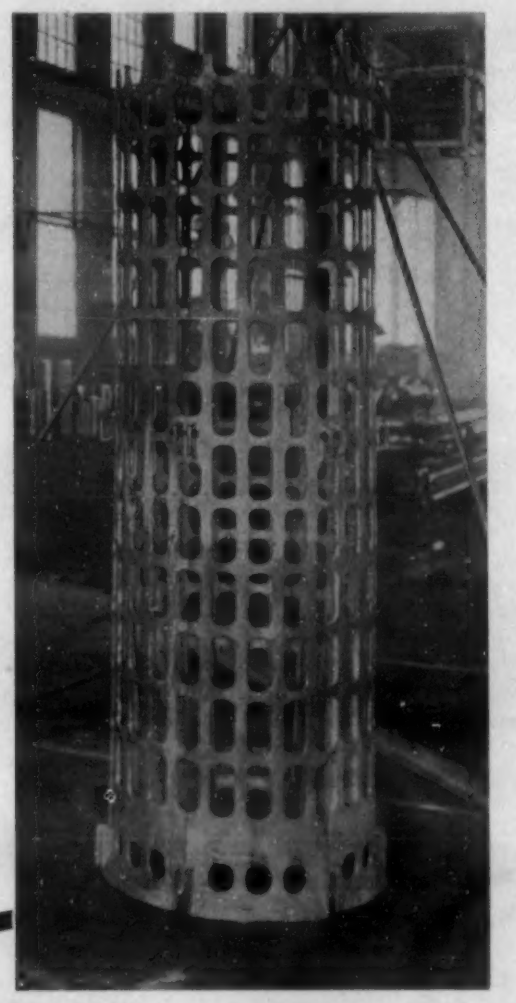
A pamphlet in red, white and blue trim describes the loyalty pledges and attendant celebration and newspaper publicity of *Surface Combustion Corp.* Toledo, Ohio, industrial furnaces and equipment. Each employee signed the following pledge: "I, the undersigned, herewith pledge my unreserved and full cooperation toward aiding Surface Combustion in performance of its part in the National War Program." There was a banquet, addressed by local and national figures, and much publicity in the newspapers.

Army Day, April 6th, for the Superior Tube Co., Norristown, Pa. was dedicated as MacArthur Day, 24 hours around the clock. Men spit on their hands and turned out a record production of metal tubing, 155,000 feet, half of which are for aircraft. An appropriate booklet in red, white and blue commemorates the day.

(More news on page 112)

DURALOY

SPECIALISTS— very definitely Specialists—in the field of HIGH ALLOY CASTINGS



THE word "Specialists" implies extensive experience in and greater knowledge of a given subject . . . and in this case the subject is Chrome-Iron and Chrome-Nickel Castings.

We have been making these very useful static castings since 1922 and since 1931 we've been making centrifugal castings. Both dates very definitely put us in the pioneering group.

With complete and modern casting facilities, we are in position to serve you on high alloy castings, ranging from less than a pound in weight to several tons. With a modern machine shop we can finish them to any degree desired.

THE DURALOY COMPANY

Office and Plant: Scottdale, Pa.

Eastern Office: 12 East 41st St., New York, N. Y.

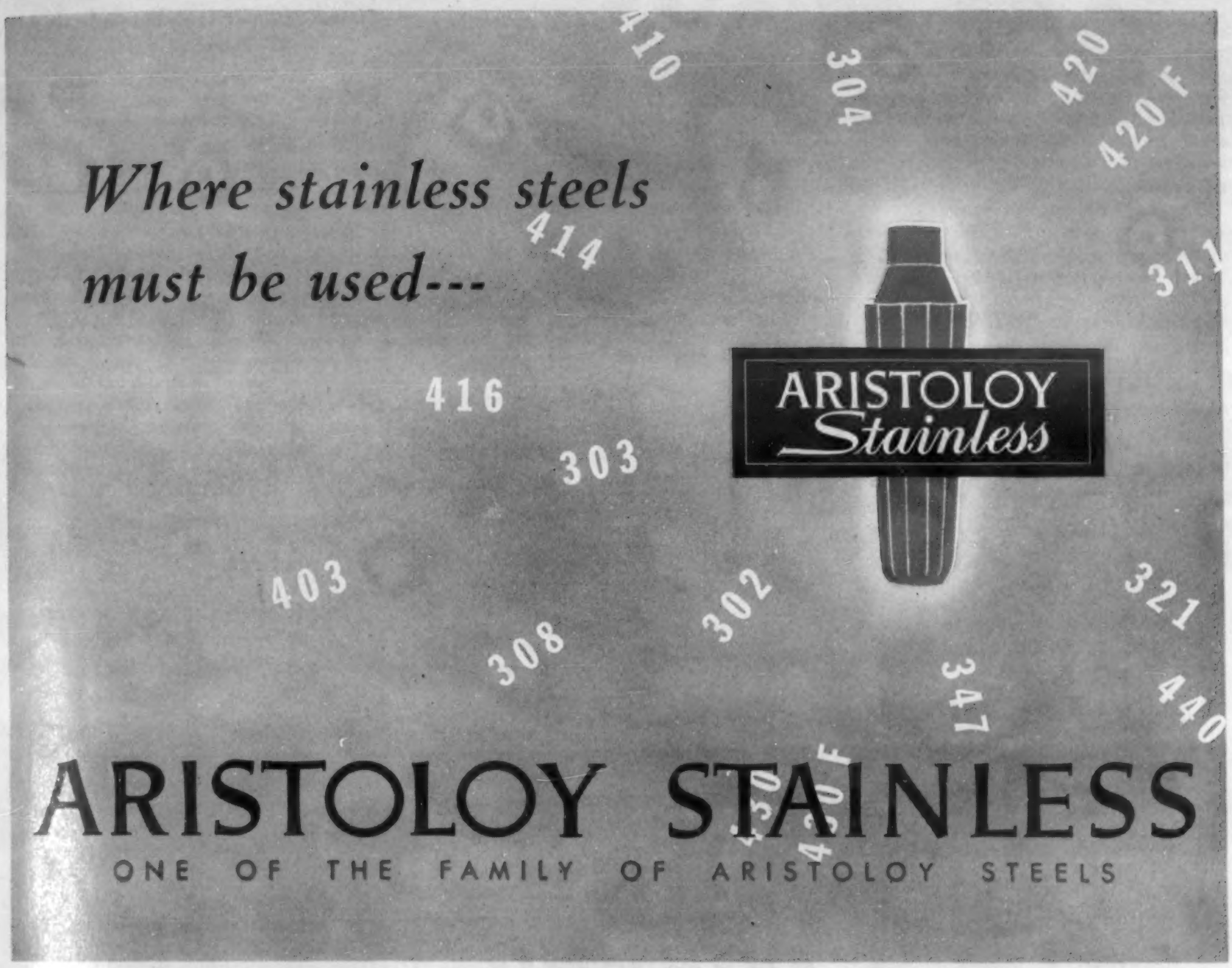
DETROIT The Duraloy Co. of Detroit

SCRANTON, PA. Coffin & Smith

LOS ANGELES Great Western Steel Co.

Metal Goods Corporation: St. Louis • Houston • Dallas • Tulsa • New Orleans

7-DU-1



To conserve nickel and chromium, all industry is cooperating to limit the use of stainless steels to vital applications where only stainless will do the job. For such applications Copperweld Steel Company is furnishing Aristoloy Stainless steel bars and billets. We'll be glad to discuss your stainless steel applications with your engineering staff.

COPPERWELD STEEL COMPANY THE WILL TO MAKE **WARREN, OHIO**

Excellent Tin from Humble Tubes

Amid atmosphere more that of a perfume counter than a factory, crumpled collapsible tubes still oozing out aromas from toothpastes, shaving creams and lotions, are converted into splendid analysis pig tin near Newark, N. J.

The enterprise is an emergency—not profitable—manufacturing operation, conducted by the Tin Salvage Institute, a unit of Metals Reserve Corp.

About six tons of old tubes are salvaged each day, with 200,000 lbs. received up to July 1. The average tube is nearly 99 per cent tin. An ingenious but simple device separates the lead from the tin. Two electric flatirons are in constant use, one heated to 450 deg. F. and the other at 620 deg. Tin melts at the former; lead at the latter.

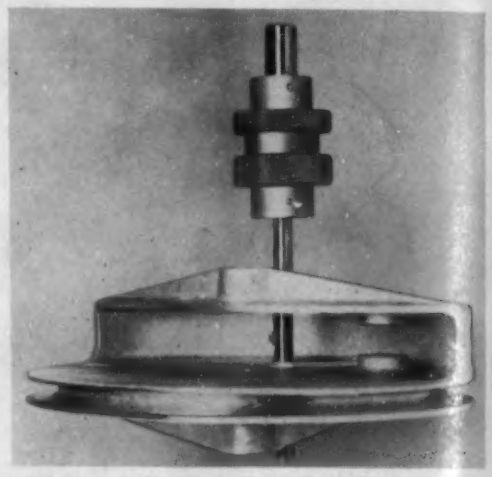
At the start of the process, tubes are dumped on a table where 8 employees remove the plastic caps for sterilization and reuse; then sort the tubes according to estimated tin content. Sorters are guided largely by easily memorized lists showing metal content of the tubes used for various brands.

Removing Burrs from Inside Edges of Multi-walled Parts

More and more are tools designed for operation by "green trainees" or women operators as well as for speed and labor-saving in our speedy war production. Such is the new burring tool, valuable for removing burrs from the inside edges of multi-walled parts, made by the *Nobur Mfg. Co.*, 6156 Santa Monica Boulevard, Hollywood, Cal. It is claimed the tool eliminates slow and costly hand methods of burring.

An essential requirement of precision aircraft parts manufacture is that the finished product be free of burrs. Use of hand files, scrapers and emery cloth is time consuming and labor wasting.

The Nobur tool, used in a drill press, lathe or other machine spindle, consists of



a cylindrical shaft which pilots in the hole to be de-burred; to one end is fastened a knurled collar, which is a free-rolling ball bearing unit which can be held while the shaft rotates. By sliding the collar up or down, the burring blade may be advanced into cutting position or withdrawn.

You'll find a
FIGHTING ALLOY
in "BERALOY 25"

BERYLLIUM Copper

"The Alloy that doesn't get tired."

Fulfills unique tasks that cannot be performed by any other metal or alloy.

We have the facilities, personnel, and experience to meet the most exacting specifications.

WILBUR B. DRIVER CO.
NEWARK, NEW JERSEY

Manufacturers of "TOPHET"* the Nickel-Chrome Resistance Wire
*TRADE MARK REG. U. S. PAT. OFF.

Meetings and Expositions

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual convention. Spokane, Wash. July 22-24, 1942.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, Pacific Coast convention. Vancouver, B. C. Sept. 9-11, 1942.

AMERICAN CHEMICAL SOCIETY, semi-annual meeting. Buffalo, N. Y. Sept. 11-17, 1942.

NATIONAL PETROLEUM ASSOCIATION, annual meeting. Atlantic City, N. J. Sept. 16-18, 1942.

ASSOCIATION OF IRON & STEEL ENGINEERS, annual convention. Pittsburgh, Pa. Sept. 22-24, 1942.

SOCIETY OF AUTOMOTIVE ENGINEERS, national tractor meeting. Milwaukee, Wis. Sept. 24-25, 1942.

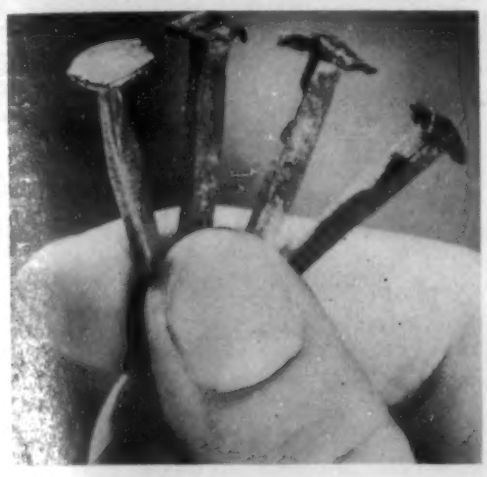
TECHNICAL ASSOCIATION OF THE PULP & PAPER INDUSTRY. Boston, Mass. Sept. 29-30, 1942.

Burrs and Feathers

"They don't put real stuff into things nowadays" is a complaint heard frequently. Grandpappy claims that the steel in the old straight-edge razors was far superior to the wafer safety blades of today. Granny says the old-fashioned home-made bread was better than the stuff from the baker's today. Grandson smiles tolerantly.

Grandpappy might be right as regards wrought iron nails, 290 years in service, taken out of Smith's Fort Plantation, Surry County, Va., the oldest brick building in Virginia. Driven in 1652, they were square cut out of genuine wrought iron, giving them more holding power and resistance to corrosion than the steel wire type generally used today.

The Tremont Nail Co., Wareham, Mass., an old-timer and one of the few still manufacturing wrought iron nails as they were made in Colonial times, produced a



modern unused counterpart of the original to illustrate the remarkable lack of corrosion.

[In the accompanying photograph, left to right, are a modern nail and three wrought iron nails, in use 290 years. Heads show some wear, but bodies would indicate plenty of vitamins.]

Those old enough to have attended vaudeville in its earlier heyday recall the old gag about the Scotsman who fried his bacon in "Lux"—so it would not shrink.

Almost as fantastic, at first perusal at least, is the adaptation of this cleaner of ladies' dainties and unmentionables, "Lux," for broaching a hole in a pressure pump valve part in mass production.

At first, difficulty was experienced in obtaining the desired smoothness of finish when the hole, 3/16 in. in diam. and 2¼ in. long, was being broached.

The way we heard it, numerous cutting fluids were tried with indifferent success until the engineer (a much-married man) from the *Colonial Broach Co.,* Detroit, makers of the broach, and the valve manufacturer (father of several daughters) hit on Lux and water.

And so, dear children, Lux and the broaching operation lived happily ever after. Now, little dears, hurry to bed before those profane baldheaded men in the back row make wisecracks unfit for your tender ears! Such as "hate to broach the subject," "from panties to pressure pumps"—Quiet, please!

When you were a kid you charged three pins to attend your home-made circus. In later years, back in old Homesteadville, you got up a minister's donation—a surprise party where all the good people of the community brought pumpkins, eggs, cheese, oats, bags of coal, strings of perch and bullheads—all to keep the parson provided with earthly goods for another month or so. Much of the foodstuff was too tough to eat—but let's not go into that.

To raise money for the local volunteer fire department, citizens of Georgetown, Cal., held a scrap iron party. Price of admission was heavy melting steel, or borings or turnings, or mixed country scrap, or—what have you? This was sold to a dealer to the sweet tune of one hundred and sixty-five dollars and ninety-five cents. The hangover from this party may kill one of those little yellow monkey men of the Far East.

The City of Winchester, Va., sold an old Civil war type cannon which had adorned a park for many years, and in-

(Continued on page 114)

Guide to Selection of DURCO Alloys

TABLE OF RESISTANCE TO CORROSIVE SOLUTIONS

The table given below is intended simply as a guide for the general selection of Durco alloys. Since conditions of application and operation should be considered, it is not a conclusive recommendation for all conditions.

A—Indicates satisfactory resistance.
B—Indicates satisfactory resistance under specific conditions.
C—Indicates not recommended without special investigation.
D—Indicates not satisfactory.

	Duriron	Durichlor	Durimet	KAsS	KAsSMo
Acetic Acid, 80% hot	A	A	A	B	A
Acetic Acid, glacial, hot or cold	A	A	A	A	A
Acetic, Anhydride	A	A	A	A	A
Aluminum Sulfate + 1% H_2SO_4	A	A	A	D	A
Ammonium Chloride	A	A	A	A	A
Ammonium Sulfate	A	A	A	A	A
Ammonium Sulfate + 7% H_2SO_4	A	A	A	D	A
Ammonium Nitrate	A	A	A	A	A
Arsenic Acid	A	A	A	A	A
Acid Mine Water	A	A	A	A	A
Calcium Bi-sulphite, cold	D	D	A	A	A
Calcium Bi-sulphite, hot	D	D	A	B	C
Calcium Bi-sulphite + H_2SO_4	B	B	A	C	C
Chlorine, dry	A	A	A	C	C
Chlorine, wet	B	A	C	C	C
Chromic Acid	A	A	A	C	A
Citric Acid	A	A	A	C	B
Ferric Chloride	D	B	B	C	A
Fruit Juices	A	A	A	C	D
Hydrochloric Acid (5% max.)	B	A	A	D	B
Hydrochloric Acid, higher strengths	D	A	D	B	A
Mixed Acid (H_2SO_4 and HNO_3)	A	A	A	C	C
Nitric Acid	A	A	A	C	A
Nitric Acid and NaCl	D	A	A	B	A
Phosphoric Acid—concentrated C. P.	A	A	A	C	C
Phosphoric Acid + 3% HF	D	D	A	B	A
Sodium Hydroxide	B	B	A	C	C
Sodium Hypochlorite	B	A	B	B	B
Sodium Sulfate	A	A	A	A	A
Sodium Sulfite	D	D	A	A	A
Stannic Chloride	B	A	B	C	C
Sulfuric Acid	A	A	A	D	D
Sulfurous Acid Gas (SO_2) moist 20 deg. C.	D	D	A	A	A
Sulfurous Acid Gas (SO_2) moist 300 deg. C.	D	D	A	A	A
Sulphite Liquors, cold (calcium and sodium bi-sulphite)	D	D	A	A	A
Sulphite Liquors, hot	D	D	A	B	A
Sulphite Liquors + H_2SO_4	D	D	A	C	C

CERRO ALLOYS for Prompt Shipment

CERROMATRIX (Melting Temp., 250°F.) For securing punch and die parts, anchoring machine parts without expensive drive fits, for engraving machine models, stripper plates, chucks, short run forming dies and other metal working applications.

CERROBEND (Melting Temp., 158°F.) Used as a filler in bending thin-walled tubing to small radii. Easily removed in boiling water. Also used for aircraft assembly jigs, templates for forming dies and other purposes.

These two low-temperature-melting and expanding alloys are helping to speed up production of war materials for the Army, Navy and Air Force.

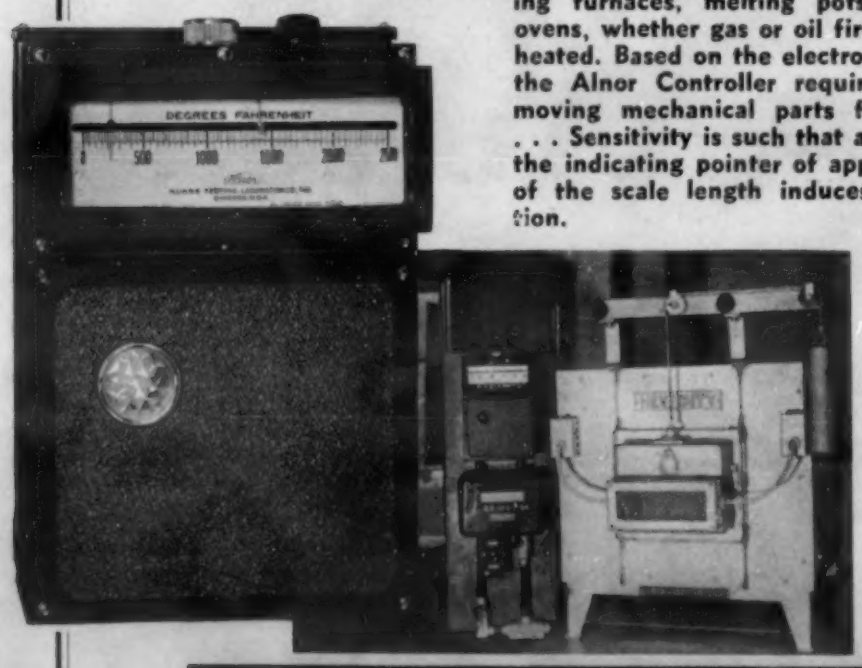
REPRESENTATIVES AND DISTRIBUTORS

Brooklyn, N. Y., Belmont Smelting & Refining Works
Ansonia, Conn., Jackson Associates
Boston, Mass., Jackson Associates
Philadelphia, Pa., Machine & Tool Designing Co.
Cleveland, Ohio, Die Supply Co.
Detroit, Mich., Castaloy Corporation
Chicago, Ill., Sterling Products Co., Inc.
Moline, Ill., Sterling Products Co., Inc.
Milwaukee, Wis., Harry C. Kettleson, Inc.
St. Louis, Mo., Metal Goods Corporation
Kansas City, Mo., Metal Goods Corporation
Tulsa, Okla., Metal Goods Corporation
New Orleans, La., Metal Goods Corporation
Dallas, Tex., Metal Goods Corporation
Houston, Tex., Metal Goods Corporation
Los Angeles, Cal., Castaloy Corporation
Montreal, Can., Dominion Merchants Ltd.
London, Eng., Mining & Chemical Products, Ltd.

CERRO DE PASCO COPPER CORPORATION
40 WALL STREET - - - NEW YORK, N. Y.

Close AUTOMATIC CONTROL OF HEAT TREATING TEMPERATURES!

THE "ALNOR" PYROMETER CONTROLLER provides a simplified, economical means of assuring highest accuracy in the fully automatic maintenance of pre-determined temperatures in heat-treating furnaces, melting pots and annealing ovens, whether gas or oil fired or electrically heated. Based on the electron tube principle, the Alnor Controller requires no motor or moving mechanical parts for its operation . . . Sensitivity is such that a displacement of the indicating pointer of approximately .2% of the scale length induces control operation.



Write today for the ALNOR INSTRUMENT CATALOG

Illinois Testing Laboratories Inc.
425 N. LaSalle St., Chicago, Illinois

vested the money in war bonds. The cannon, weighing 16,100 lbs., was purchased as scrap by the *Chambersburg Engineering Co.*, Chambersburg, Pa., melted down in their foundries and cast into the

anvil of a steam drop hammer for airplane engines. The cannon was placed in the furnace in one piece, without previous breaking up.

Steel that used to go into a single hair dryer in the beauty parlor is enough for six hand grenades.

A set of brass curtain fixtures will make 30 cartridges.

Steel in an average radio-phonograph would make a dozen bayonets.

Copper from a dozen electric fans equals a 20-mm. aircraft cannon.

Steel in a sewing machine will make a high explosive shell for a 75-mm. field howitzer.

Steel in two large outboard motors would equal a sub machine gun.

Copper in 100 electric shavers is equivalent to an airplane smoke tank for camouflage purposes.

Three Ranges of Seam Welders

A complete line of seam welders, in three capacity ranges and 126 models, is announced by *Progressive Welder Co.*, E. Outer Drive, Detroit. In each of the light, medium and heavy duty series several standard throat depths are available. Each type is available in six different standard drives, three for circular and three for straight seam welding. The Universal model, for both straight and circular welding, is available in three drive types and in each capacity range.

Several features insure long life. Thus all surfaces are lubricated to promote long life and continuous perfect alignment. A non-ferrous alloy lines the cast bearing housing, which is internally water-cooled. The solid lower arms are externally water-cooled.

Flame-Hardening Turret Rings

Flame hardening is applied to localized heat-treatment of the bearing surfaces of tank-turret rings, all automatic. The ring revolves past the stationary hardening unit, while the turntable is tilted to facilitate disposal of quenching water, which directly follows the oxy-acetylene heating flames.

Only a fractional horse-power motor is required.

The process is sponsored by the *Linde Air Products Co.*, 30 E. 42nd St., New York.

● An alternate for metal bearings is Woodex, a wood made from all sap Rock Maple, impregnated with oils and other lubricants, manufactured by the *Neveroil Bearing Co.*, Wakefield, Mass. While it will not stand the load, speed or high temperatures of graphited bronzes of the same company, it will outwear most metals when applied to correct products. Woodex has been a recognized bearing material for 40 years.

Direct Scrap Buying Bugaboo

A controversy which touches off deep feelings of long-standing in the scrap steel industry was started in early June when Lessing J. Rosenwald, chief of the Bureau of Industrial Conservation, suggested that steel mills buy unmanufactured scrap direct from original sources (without dealers serving as middlemen) and preparing the scrap in steel mills, the point of consumption.

The suggestion was made because scrap yards have become bottlenecks, with more raw material pouring in than they can handle. Because of this surfeiting of yards, lower prices were being bid which, according to Mr. Rosenwald, undermines the OPA scrap price ceilings.

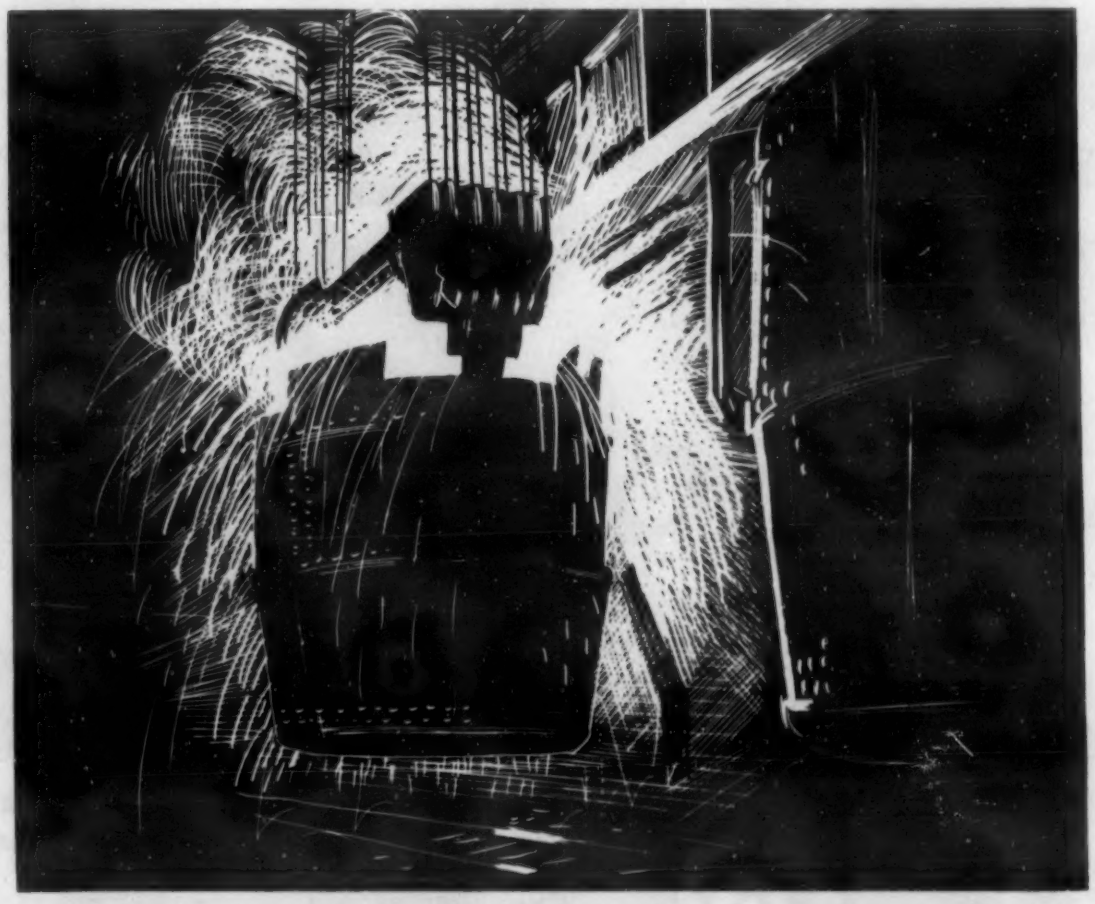
Edwin C. Barringer, president of the Institute of Scrap Iron & Steel, Inc., stated in rebuttal that the lack of labor in scrap yards makes for this bottleneck. Washington has been appealed to, but the request "has fallen on deaf ears."

Tendencies of recent years for steel mills to ignore middlemen and buy scrap directly has been the nightmare of the scrap industry, hence Mr. Rosenwald's suggestion makes a situation where the "nightmare rides again."

Scrapmen claim the average steel mill does not have the proper organization or technique for collecting scrap, sorting, cutting and otherwise preparing it. The modern scrap yard has the exact type of cranes, shears, magnets, compressors and bundling equipment needed. Sometimes a scrap firm keeps a special freight train loaded and equipped to go anyplace where a wrecking and scrapping job is to be done.

Former nightmares have been borne because of past tendencies of steel mills to buy direct from railroads or other large sources of scrap. Often the "purchases" were actually trades. A steel mill would offer a certain tonnage of new rails to a railroad in return for a larger tonnage of scrap rails. The scrap dealer did not figure in the transaction. The dealer claims he has an important niche to fill in the economic scheme of things. He claims he is a refined scrap manufacturer by collecting, sorting, cutting and classifying raw materials, and making it a finished product.

One further complaint from the dealer is that he gets no subsidy from the government, but the steel mill gets the new blast furnace or open-hearth with government funds.



Rigid control

from open hearth to finished product puts the

QUALITY IN STANDARD FORGINGS

At each step in the manufacturing process —from acid open hearth to finished forging—Standard exercises the most rigid, painstaking control. The materials used in Standard products are carefully analyzed by especially trained metallurgists and chemists, using the most modern approved testing equipment. Their job is to safeguard the quality built into every forging delivered to a Standard customer.

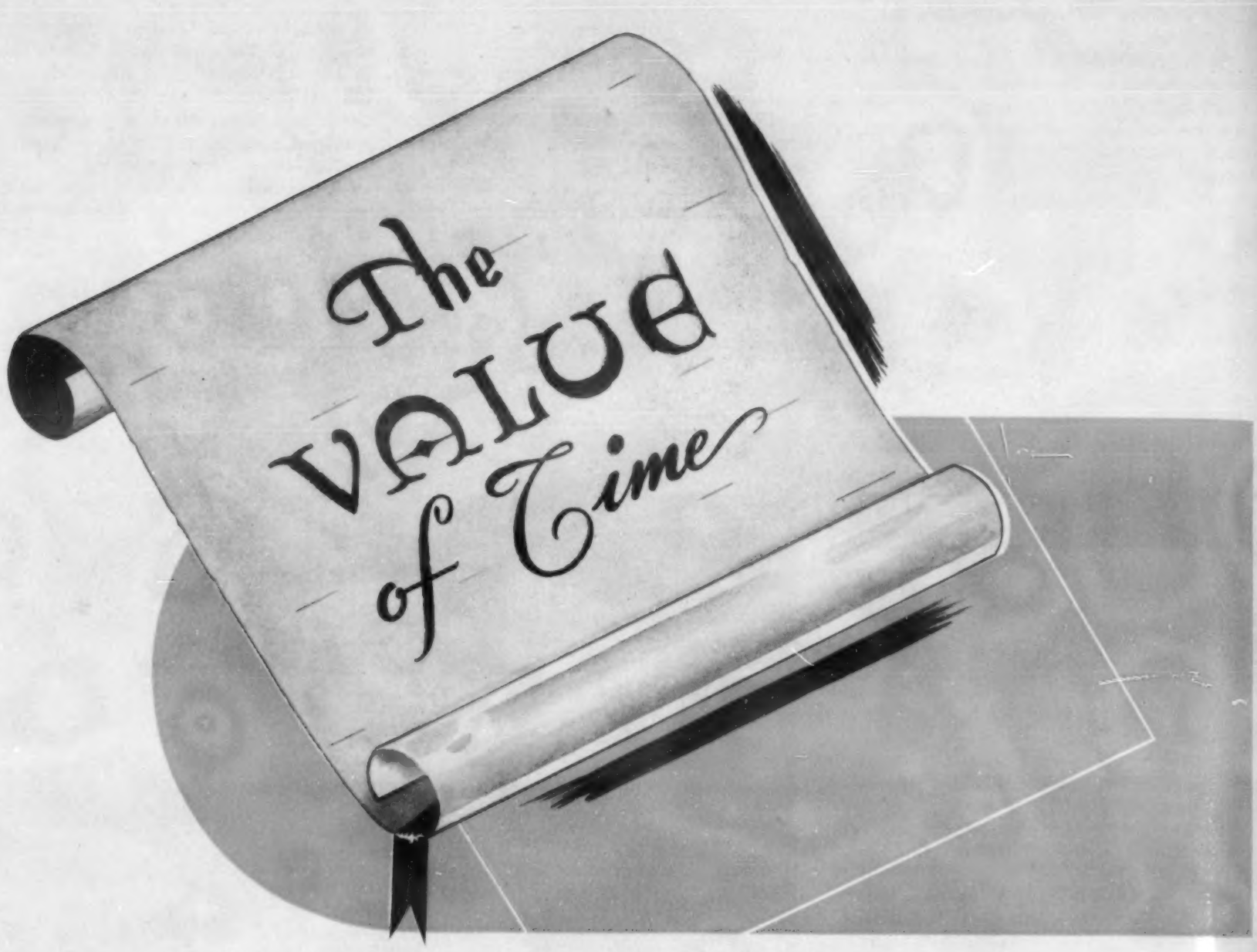
The Standard Steel Works Division of The Baldwin Locomotive Works traces its origin to the Freedom Forge, which was established in 1795. From those early days through the present Standard has kept pace with modern developments in the manufacture of steel products.

Thus, today, in the 119-acre Standard plant, quality is kept at peak, unaffected by tremendous war-time demands.

FORGINGS • CASTINGS • WELDLESS RINGS • STEEL WHEELS

STANDARD STEEL WORKS

DIVISION OF
THE BALDWIN LOCOMOTIVE WORKS
PHILADELPHIA

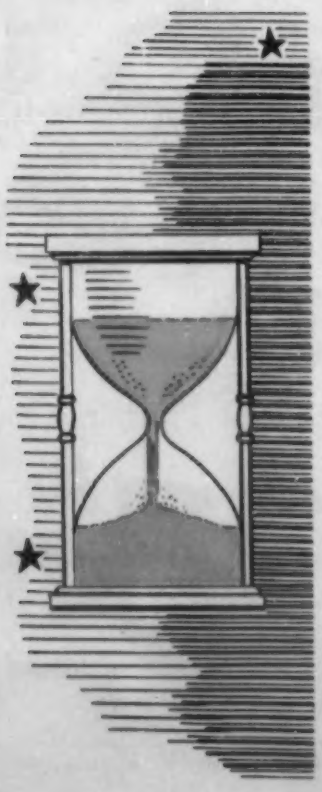


TIME is one of the most basic things in our lives. *Without* it, we can do nothing. *With* it, all things that are, have been made possible.

While we are not all created equal in physical or mental stature, we are all endowed with virtually the same amount of time. For remember, no man has an available total of more than 24 hours in any day.

When Seneca spoke in the city of Rome, he stressed his point by saying, "Time is the one loan which even a grateful recipient cannot repay."

The conservation of *time* is just as basic as the conservation of materials. For what good are all the precious metals and other materials to us unless we can shorten the element of time in producing and fabricating them for victory? Just as we put castings under the physical X-ray so let us put the value of time under the mental X-ray. Then we can eliminate the flaws and get sixty minutes of production out of every hour, in this time of need.



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METALLURGICAL ENGINEERING shop notes

Quenching Solid Dies

by H. C. Griggs,
Waterbury-Farrel Foundry & Machine Co.

A simple and effective device for quenching solid dies for cold headers has been copied by several die makers. The problem has been so to quench as to provide great internal hardness yet have a relatively soft exterior for greater strength without stress.

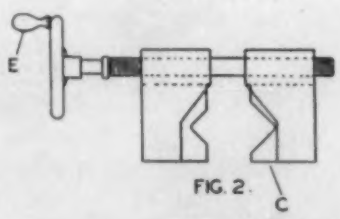

FIG. 2

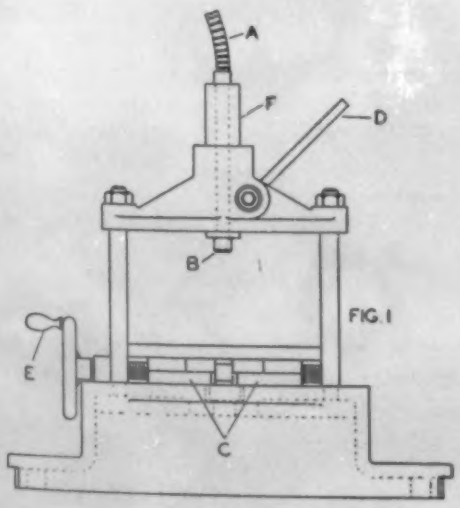

FIG. 1

These cylindrical dies are of various sizes, an average being 2 in. long, 2 in. outside diam., with ¼ in. hole through the center. They are of straight carbon or carbon-vanadium steels. Solid dies are more quickly and economically made, conserving tool steel.

The dies must be file-hard inside, with a Rockwell C hardness of 66, as quenched. External hardness is 31 Rockwell C. The dies are forged, rough machined and heated at about 1550 deg. F. for periods varying with die size.

Quenching requirements were drastic pressure with water inside, with air externally. A special fixture was built, as shown by accompanying sketches. Fig. 1 shows a cross section vertically and Fig. 2 a top elevation of the fixture itself, which holds the die in place.

City water, at normal pressure, is fed through the flexible hose (A) at the top; it flows through a rifled tip (B) which provides a whirling spray. The hot die is quickly removed from the furnace and inserted in the jaws of the fixture (C) which are tightened by the hand wheel (E). The quenching fixture (F) is lowered by the ratchet handle (D) to compress the tip of the nozzle (B) tightly on the die. The valve at the hose connection turns on the water for a quench of a few seconds.

—The Houghton Line,
E. F. Houghton & Co.

Flame-Hardening Emergency Steels

by A. K. Seemann,
Linde Air Products Co.

The use of National Emergency steels often calls for different handling and treatments than what the steel manufacturer is accustomed to. The treatments need not necessarily be complex.

Thus, oxy-acetylene flame-hardening is often satisfactory for such parts as dies, shear blades, pump liners and piston rods. It imparts maximum hardness to the surface of quench-hardenable steels without changing chemical composition or affecting toughness and ductility of the core.

Parts can be furnace-treated for core and then flame-hardened for surface, the hardening restricted to where needed, with degree and depth controlled accurately.

Equipment is convenient, consisting of one or more flame-hardening heads which furnish oxy-acetylene heating flames, an oil or water quench, and a means of propelling the head and quench at a set speed, or of turning the part being hardened.

A plating tank was welded from 56 pieces of scrap steel. The idea was inspired by the inability to buy prime steel plates. Though the tank looks like a crazy quilt, it is efficient. Some pieces are as small as 4 in. square. Two tanks have been made by this method.

—Union Steel Products Co.

(More Shop Notes on page 118)

Hollow Drill for Micro-Sampling

by Charles T. Eakin
Westinghouse Electric & Mfg. Co.

The usual slow and laborious procedure for obtaining specimens from castings, forgings, rolled and welded parts for microscopic analysis is to saw them out. Westinghouse Electric & Mfg. Co., East Pittsburgh, has adopted a tubular drill for extracting solid test samples, a method which saves much time, does not weaken the part being tested (provided it is sufficiently bulky), while the surface material is preserved for inspection.

Essentially, the drill is a tubular member having several cutting teeth at one end. The drill contains a removable centering

device consisting of a pin and spring inside the shaft. Held in the chuck of an ordinary stationary or portable air, electric, or hand drill, no jigs are required. The drill is operated conventionally.

To use, a pilot hole, 1/8 in. diam. and same in depth, is made with a standard twist drill. The tubular member is then clamped in the chuck, the spring and the centering pin placed in the tubular member. The centering pin is placed to extend beyond the drill teeth; the nipple is inserted in the pilot hole.

After the drill has cut into the piece 1/16 in. it is withdrawn to let the pin and spring drop out. Then drilling is resumed to the desired depth. The solid core formed inside the tubular shaft is removed by flexing until it breaks off at the base. This core, of course, is the sample.

Until recently, makers of "Caterpillar" Diesel Motor Graders bought bar stock, machining it to required dimensions for various parts, particularly the forged sprockets for the tandem drive housing. The latter were machined from blank forgings, which resulted in much waste of material and labor. Now they buy many drop forged parts, which not only saves weight, but wear on tools, increasing the rate of machining of parts 15 per cent.

—*Drop Forging Topics,*
Drop Forging Assn.

Bolts up to 1½ in. in dia. can be made economically by forging the heads in a standard upsetting machine. But larger sizes may often better be made by welding. Here standard round bars are sawed to length and threaded for the bolt body. Heads are welded on the bodies with regular mild steel electrodes in single passes of 1⅜ in. lengths. One steel company, when forging 150 bolts, found costs $323.95. In producing the same sizes and quantities by arc welding the cost was $210.77, a saving of 35 per cent.

Salvaging by Chromium Plating

By chromium plating parts that have been machined off-size, many plants are reclaiming rejects that would otherwise be scrapped. The problem of replacing parts of worn equipment and certain production tools is often solved by building up the worn areas with chromium. Usually the reclaimed part lasts longer than the original because of the hardness and wear-resistance of chromium.

Successful applications of chromium plating for salvage include ball and roller bearing parts, drive shafts, axles, pistons, cylinders, pneumatic tool parts, valves, taps, dies, jigs, fixtures and gages.

Oversize holes in gears and similar parts are chromium plated, then ground to size. One plant salvaged several hundred cut and draw-punches with off-center punch bearings by grinding them oversize, then plating. One plant completed an order for 700 spindles, but the specifications were changed, they now being too small by several thousandths of an inch. They were built up with electrodeposited chromium.

A small machine shop had 16 old drill presses with badly worn spindles. They were chromium plated and are doing precision work.

Often there is a slight extra cost involved, but the all-important speed factor has been attained.

—*The Last Thousandth of an Inch That Speeds Production,*
—United Chromium, Inc.

Discarded special metal parts can often be salvaged and used as raw materials when the customarily employed alloy is impossible to get. For example, a steel mill needed water spray nozzles for descaling work. These contain a hard, corrosion and erosion resisting alloy to stand punishment. The critical materials situation seemed to say "No." The engineer remembered that in the pickle house were discarded Monel tie-rods, salvaged from an old pickling tank. There was more than enough stock for machining all the nozzles he wanted—and they cost less than what he had been paying. The engineer remembered that many a valve stem had been made from an old Monel pump shaft; many a new bolt from an old valve stem.

—*Mechanical Topics,*
International Nickel Co., Inc.

Stock Bins for Small Items

Handy stock bins for holding bolts, nuts, nails, staples and similar small items where they will be readily accessible can be made in a few minutes and from discarded materials. Requisites are old boiler tubes or scrap pipe to form the framework of the rack and empty cans or small drums of uniform size for the containers. A welding blowpipe is the sole tool needed.

Four pipes are used to form the bottom of the shelves, so spaced that the drums or cans will be inclined at an angle of about 45 deg. Four longer pipes form the vertical members of the frame and four more pipes, the same length as the bottom four, form the top. As many tiers as wanted, provided the longitudinal pipes are long enough, can be provided for. When the cans are in place, there are two batteries of container, each facing on opposite sides of the rack. Size, price or other pertinent information can be chalked or painted on top of each container.

—*Oxyacetylene Tips,*
Linde Air Products Company

Springs are finding interesting new uses in the great production effort. A pin is now used to hold the skin on bomber wings prior to riveting. When riveting is over, pins are easily taken out through their spring action.

—*The Mainspring,*
Wallace Barnes Company

Ways of Cleaning Stainless Steel

Stainless steel lasts longer if kept spotlessly clean. Soap and water will remove ordinary deposits of grease, dirt and similar contaminations. Washing should be followed with a water rinse and thorough drying.

Tightly adhering deposits of food, oil, grease, weather stains, milk-stone or other light discoloration may be removed by any of the following: Grade FFF Italian pumice, whiting or Bon Ami; Liquid Nu Steel; Paste Nu Steel; household cleaners such as Old Dutch, Gold Dust and Sapolio; Cooper's Stainless Steel cleaner; Allen Stainless Steel Cleaner.

Heat tint or heavy discoloration may be removed by: Allen Stainless Steel Polish; Wyandotte or Bab-O, or Nu Steel.

Where swabbing or rubbing is not practical, the following are applicable: Caustic soda, 5 to 15 per cent; sodium metasilicate, or trisodium phosphate, or sodium metaphosphate or sodium pyrophosphate, all 1 to 5 per cent.

For removing oils or grease deposits, the following can be used where food containers are not involved: Carbon tetrachloride, trichlorethylene, acetone, kerosene and allied products.

Ordinary steel wool or steel brushes should never be used.

—Republic Steel Corp.

Metallurgical Engineering Digest

FERROUS AND NON-FERROUS

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Using Sinter in the Blast Furnace

Condensed from "Steel"

More than 4 years' test runs by Republic Steel Corp. on small and large blast furnaces producing basic and Bessemer iron gave very interesting results. A composite average of performance shows that the increase in daily iron production bears an almost direct relationship to an increase in the percentage of good quality sinter in the burden, up to 45%.

With this percentage of sinter in the total burden, iron production increased 14% over that when no sinter was used. With 45% of sinter to total ore and sinter, coke consumption and flux consumption per ton of iron decreased 16% and 22%, respectively, compared with the consumption when no sinter was used. When burden contained 45% sinter and scrap, the flue dust produced was 53.5% less than that present in a furnace operating a sinter-free Lake Superior ore burden.

No experience on the furnaces beyond 45% sinter in the burden is available, but results from another furnace on 100% sinter indicate that beyond 45% there is little further advantage other than the increased iron units in the sinter. One of the chief reasons for this is that the burden becomes so open that intimate gas-solid contact is not maintained.

To increase the pig-iron production of the country by increasing the percentage of sinter in the burden would require construction of considerable new sintering capacity. However, a sintering plant of 1200 tons daily capacity can be built in much less time than that required to build a blast-furnace and can be constructed for about 5% of the cost of a modern blast-furnace. Additional coke-oven capacity would not be required.

—*Steel*, Vol. 110, May 11, 1942, pp. 107-108.

Carbide Dies for Wire Drawing

Condensed from "Canadian Metals & Met. Industries"

Introduced more than a decade ago, cemented carbide wire drawing dies are today regarded as standard tools of the wire industry. In the past few years a widening scope of uses for carbide dies has developed in steel mills, as well as in companies working with brass and aluminum.

Today, carbide drawing dies fall, generally speaking, into one of the three following classifications:

1. Conventional round wire drawing.
2. Drawing of standard shapes (hexagonal, square, etc.).
3. Drawing of special shapes of wire and of special shape parts as an alternative to machining from bar stock.

While steel dies are still being extensively used for the third mentioned class of work, carbide dies are being applied where close tolerances must be maintained over long runs.

Round Wire Drawing

With demand for wire at a peak and

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As steel furnaces continue to operate at or near capacity, refractories are subjected to greater strain and faster wear. Thus good refractories, properly applied, are increasingly important to the steady, efficient production of open hearth and electric furnace steel.

To the men who operate the furnaces—men successful in meeting production problems with ability and judgment—we offer the assistance of a staff of trained engineers, capable men to service good refractories.

Basic Field Engineers are, first of all, experienced steel men. From years of work with the open hearth they know the practical side of steel making. They also know refractories. Their specialized training and knowledge enable them to tell how refractories will act under variable conditions.

You, as a busy open hearth or electric furnace operator, can confidently rely on the Basic Engineer as your refractories service man. His job is to supervise and assist with the installation of new hearths, major repairs and special applications. In fact, there may be numerous situations on which he may be able to advise you so as to reduce delay time and lower refractory costs.

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GUNMIX—A basic refractory with chemical bond, sized for use with a cement gun.

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mills straining effort to maintain production at high levels, proper die maintenance procedure has become more important than ever before. Dies should never be allowed to wear until a deep ring has been formed. They should be touched up, if necessary, every time they are returned to the die room—and as soon as they do, so that they will be ready when needed.

Regular touching up of dies eliminates, to a large extent, the necessity of recutting dies, eliminates tie-ups, reduces down-time of mill equipment, reduces spoilage, increases mill tonnage and, actually results in cutting down on the number of man-hours required to finish and refinish dies.

Standard Shapes

Drawing of special shapes with carbide dies is a more recent development and has been materially stimulated by the introduction of shape-die finishing equipment. With this equipment, mills are now able to purchase rough-cored dies and finish such dies themselves.

The finishing equipment is also used to keep the die in condition. In addition to die-finishing equipment, the shape-die equipment available includes machines for producing the special laps needed for the shape dies.

One practice fairly widely followed is to save the first lengths drawn through the shape die to cut up for "laps" for use when reconditioning the die. Laps produced in this manner may be used even if slightly undersize with respect to the desired hole dimensions, by applying side pressure to the laps when lapping.

It should be noted, however, that many special-shape dies are still being produced from round hole dies. Mills faced with the requirement of relatively short runs on special shapes find it quicker and more economical to produce the necessary special die by shaping a round hole available on the mill's shelves. However, it should be noted that this method is satisfactory, mainly when the shapes to be produced are relatively simple in character.

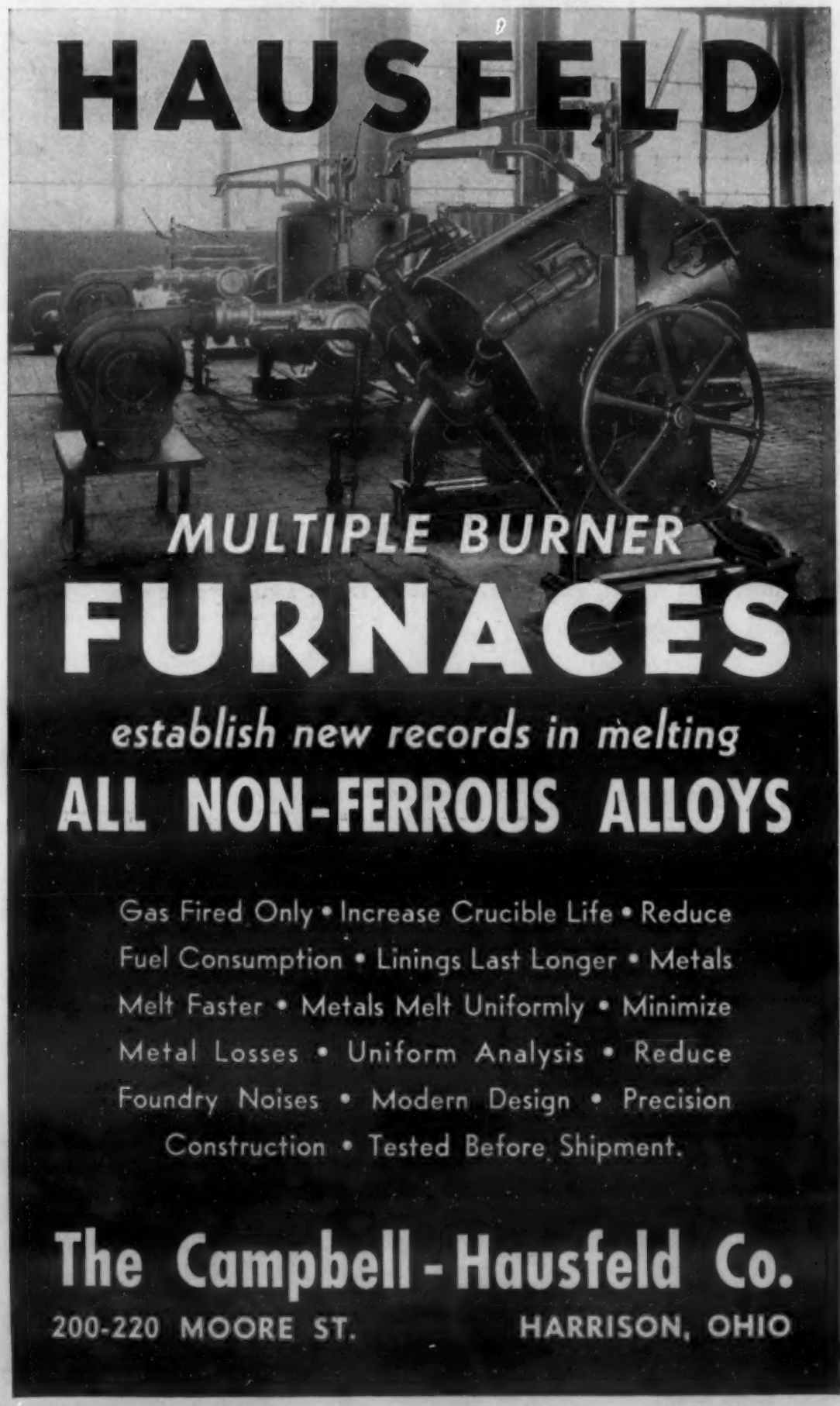
Non-ferrous Shapes

Though steel mills have advanced quite a step in producing special shapes by the carbide drawing process, the intricacies of shapes are nowhere near those to be found today in drawing of brass and other non-ferrous metals with such dies. Thus, an irregular brass part formerly produced by milling is now bench drawn to the final shape and cut into the desired short lengths, without needing any machining operations.

This general type of part seems to hold major promise for future increases in production by drawing with carbide dies rather than machining, as the former enables manufacturers to produce parts to extremely close tolerances and identical in every detail, resulting in parts with dimensions held to the same limits as in machining.

This is particularly important in progressive assembly work, where one misfit can cause a great deal of trouble. In addition, there is the saving in production cost involved, which in some cases might easily mount up to 90 per cent of the original processing cost.

—J. R. Longwell, *Can. Metals & Met. Inds.*, Vol. 5, May 1942, pp. 147-148.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Impact-Extrusion of Aluminum

Condensed from "Light Metals"

It is well known that a large variety of can or tube-shaped articles can be formed in aluminum by impact extrusion. Ordinarily 99% Al or better grade metal is used in such work, but there is probably no reason why aluminum of a somewhat less pure grade could not be successfully utilized.

It is said that attempts have been made to impact extrude soft Al alloys in England and in Germany, but no information is available as to the success of the work. Naturally, the power requirement is much greater for alloys than for pure aluminum.

The first step is blanking the slug; the second step—a shaving operation—is recommended for insuring a proper fit in the die. Annealing may be necessary to insure uniformity in condition of all the blanks, but it is not always used.

A Vickers hardness of 33 for slugs of "high purity" aluminum is typical, and at such a hardness level, annealing may not be necessary. On the other hand, a Vickers hardness of 40-50 is too hard, and annealing is almost certainly required.

The blank is lubricated by immersion in

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Tungsten is recognized as important in so many uses that no effort need be made to enlarge upon them here. Technical advice will be given on request.

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Grant Building, Pittsburgh, Pa.

a thin lubricant; too heavy a lubricant causes a poor surface condition on the pressed article. Ordinarily deep drawing compounds are not satisfactory. A mixture of 10 parts water and 1 part emulsion oil has been used successfully.

The slug is placed rounded face downwards into the die, the faces of which are blended with generous radii. The bottom of the die, a solid tool, has some curvature, and the entrance edges are rounded. The punch must be very accurately set up, and delivers a rapid blow from a 100-200 ton press. The aluminum pressing is heated to about 200 deg. F. by the forming operation.

Owing to the shaping of the mating faces of the punch and die, and contractional forces, the bottom of the pressing is not flat and is of uneven thickness, which may vary as much as 2-1. In order to flatten the base, and iron out thickness irregularities, the impact extruded can is placed in a flattening press.

A high-carbon high-chromium (2 per cent C, 12 Cr) steel is preferred for the punch and die for impact extrusion. [*The hardness of the steel is not specified, but the tempering treatment recommended is 2 hrs. at 400 deg. F.—A.U.S.*] Another tool steel suggested contains 0.65 per cent C, 1.1 Si, 0.55 Mn, 1.1 Cr, 1.1 V (max. values). The maximum hardness is given as 260 Vickers [*normalized hardness?—A.U.S.*]

Impact extrusion is well adapted to mass-production work, has a minimum number of operations, and is characterized by accuracy and speed, with less material scrap than other methods; but uniformity of raw material and blanks, experienced tool making, and precise tool and press setting are essential.

—*Light Metals*, Vol. 5, May 1942, p. 177

High Strength Alloy Cast Iron

Condensed from "Foundry Trade Journal"

The question of complete soundness and freedom from liquid shrinkage defects in high-strength cast iron becomes more and more important as the service demanded from such castings becomes more severe. When dealing with low-strength gray iron castings possessing 25,000-35,000 lbs. per sq. in. tensile strength, minor unrevealed liquid shrinkage defects are not nearly so disastrous, provided the castings are pressure tight, as in the case when the material has to exhibit very high mechanical properties.

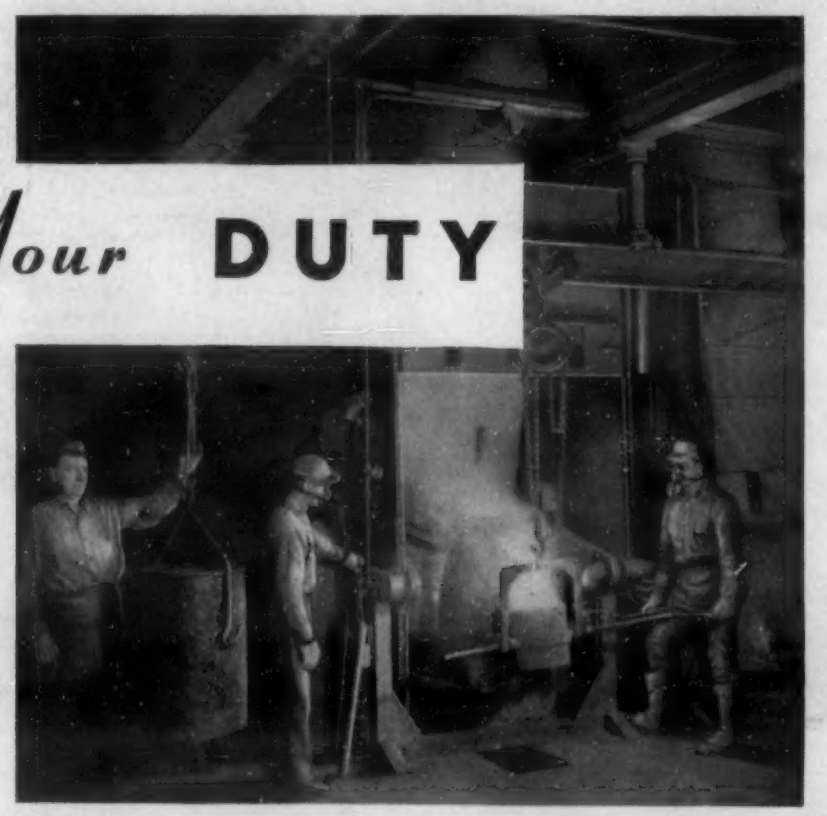
The higher the total carbon and, therefore, the greater the amount of free graphite present, the lower will be the strength. Experience shows, however, that in the lower range of carbon content cast irons are prone to exhibit a graphite arrangement that has been variously described as eutectic graphite or more recently "grain boundary" graphite. When this type of graphite arrangement is present in a casting, the mechanical properties are always inferior to those corresponding to the same amount of free graphite arranged in random patterns.

Phosphorus in excess of 0.20% tends to favor the formation of pearlite with a sudden decrease in mechanical properties for any given alloy and carbon content. One can visualize a time when the intermediate strength gray cast irons might cease to be used except for limited and special fields of application. Industry would then be left with the straight phosphoric cast irons of low strength (which will always cover a vast proportion of gray-iron requirements) and the really high-strength cast irons comparable in tensile strength with steel castings and forgings, but also possessing the special characteristics of true cast iron.

The medium-strength alloy and non-alloy cast irons would still find a useful field on account of their special properties, such as high wear resistance, etc. For example, the gray martensitic and white martensitic cast irons will continue to be used more and more extensively.

One sketch illustrates the use of shrink bobs for solid ball castings. It may be noted that shrink bobs are more often associated with the production of malleable iron than gray cast iron, but they can be used effectively to promote soundness in small lumpy castings, particularly where these are being machine-molded from a number of patterns on a plate.

—A. E. McRae Smith, *Foundry Trade J.*, Vol. 66, Apr. 9, 1942, pp. 225-228; Apr. 16, 1942, pp. 241-244.



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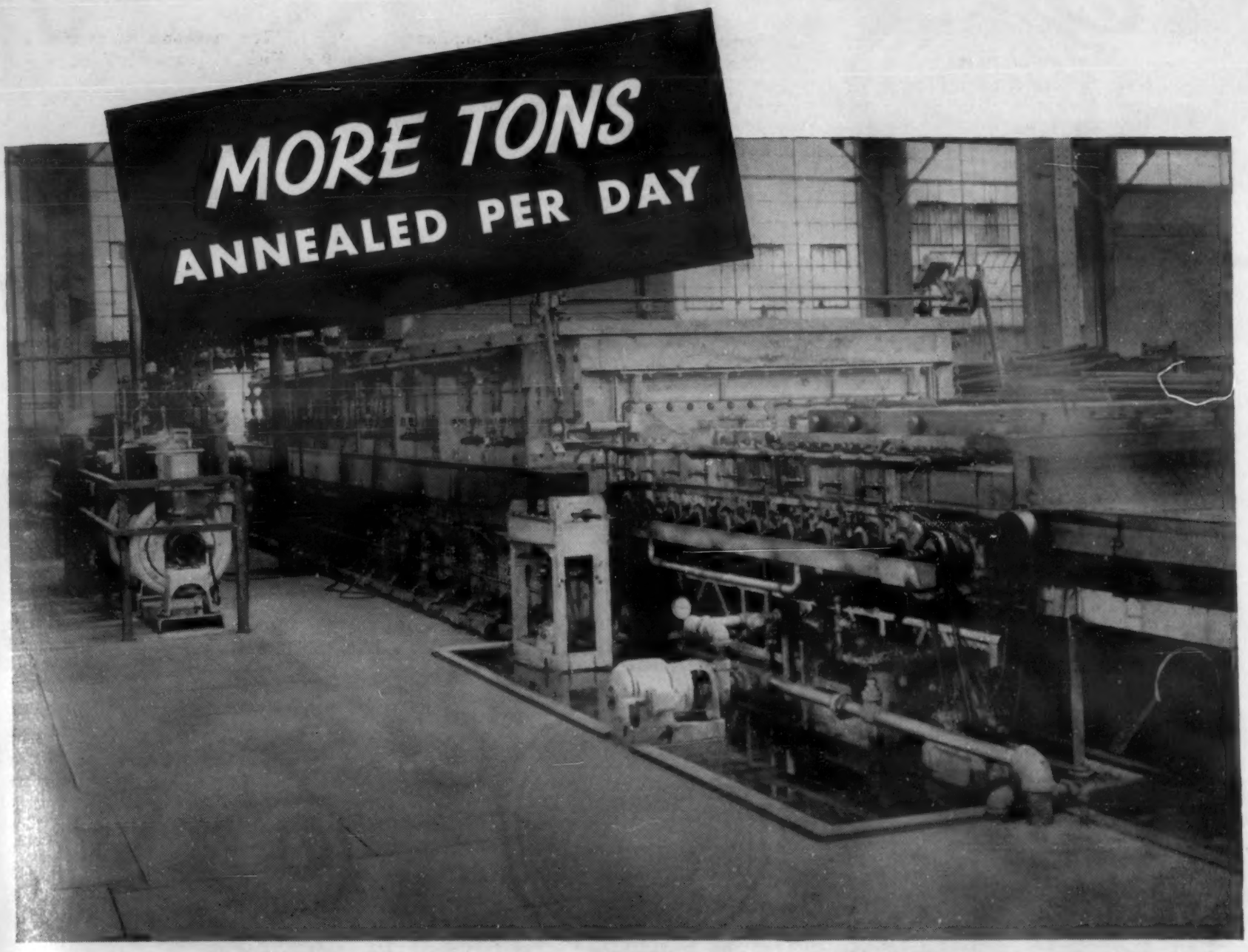

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Bessemer Open Hearth Duplexing

Condensed from
"Blast Furnace & Steel Plant"

The duplexing described combines partial refining of pig iron in an acid Bessemer converter with final processing in a basic open hearth furnace. The availability and market price of scrap have influenced the development of the Bessemer open hearth duplex process.

Tilting open hearth furnaces are used, as they permit flushing of slag at will and assure good tapping practice. While the initial cost of a tilting furnace is much higher than that of a stationary furnace of the same capacity, the investment cost per ton of capacity, excluding Bessemer units, is substantially less for a duplex shop, because production by duplex process is 2½ times that by the scrap and hot metal process in a stationary furnace.

The blast furnace iron used contains 4-4.5% C, 0.70 max. Mn, 0.20 max. P, 0.050 max. S and 1-1.30 Si. Blown metal for duplexing is produced in the converter by the same end-point control methods developed for the control of Bessemer steel quality. A considerable proportion of duplex metal is blown to 0.10-0.20% C. The tilting furnace may be completely emptied at tap or a small pool of metal may be left in the furnace.

Fluxes are charged immediately after preceding heat has been tapped and are allowed to melt for 45-60 min. Blown metal may then be charged, followed immediately by the blast-furnace iron necessary for working the heat. With 25-ton converters, 1 hr. is required for charging blown metal and iron for a 150-net-ton heat.

The quantity of blast-furnace iron required depends upon several factors, but generally will not be less than 5% of the metallic charge and may occasionally be as high as 30%. Time on heat is directly proportional to the carbon content of the bath at fill-up. For example, in making duplex heats with ladle carbon under 0.15%, average time on heat is 10% greater when fill-up carbon is 0.35-0.49% and 34% greater when fill-up carbon is 0.65% and over than when fill-up carbon is under 0.20%.

The fuel cost per ton in duplexing is about half the usual cost in conventional practice. In duplexing, the yield from blast-furnace iron to ingots is about 3-4% less than the yield from the total metallic charge to ingots in the usual scrap and hot metal practice.

From a metallurgical point of view, the duplex process has certain advantages over other open hearth processes in that raw materials are more uniform; there is a minimum of undesirable residual alloying elements; the all-liquid charge is conveniently and quickly introduced into the tilting furnace; metallic elimination is rapid; bath uniformity is easily obtained; and temperature difficulties are rarely encountered.

To improve the ability of the slag to hold phosphorous and sulphur, an appreciable quantity of reaction slag may be flushed with the raw iron addition, forming a new basic slag with suitable flux additions. The best alloy for furnace deoxidation is A.S.T.M. A 98, Grade B spiegeleisen containing manganese and silicon in a 4:1 ratio. Procedure for ladle deoxidation is about the same as for stationary open hearth heats.

Duplex process permits making steels with various amounts of nitrogen. Final nitrogen content decreases with increasing carbon in the bath after fill up, with increasing carbon in the bath after raw iron addition, and with increase in the amount of raw iron used in fill up. The amount of nitrogen absorbed by the metal in the converter also depends upon the temperature. Therefore, in duplex operation nitrogen control may be attained by temperature control of the blown metal charge and by control of fill up carbon and subsequent rate of carbon elimination in the open hearth furnace.

For static stress applications, duplex steel with normal nitrogen content (0.008-0.010%) is advantageous because of the somewhat higher tensile strength and yield-tensile ratio. Duplex steel may be used for any purpose involving severe cold work provided the nitrogen content is controlled and suitable deoxidation and mold practices are employed.

—H. B. Emerick & S. Feigenbaum, *Blast Furnace & Steel Plant*, Vol. 30, May 1942, pp. 521-531.

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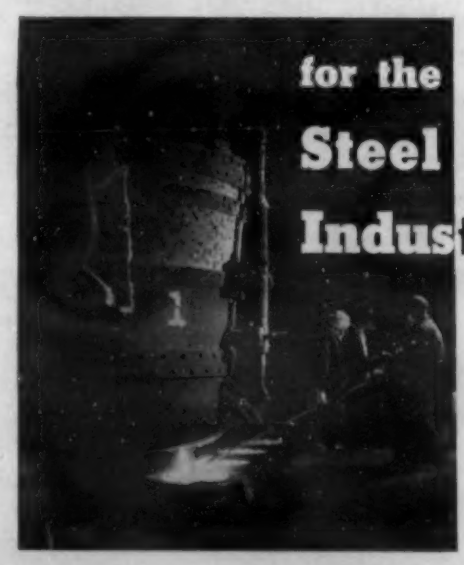

NUMBER 12

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R-90

Aluminum Permold Castings

Condensed from "The Iron Age"

Some unusual aluminum permanent mold castings are used in aircraft and mobile ordnance units.

The permanent molds are made from special grades of heat resistant cast iron, which is given a refractory coating applied by spraying. Proper gating is of great importance. Molds for semi-permanent castings are the same as for permanent mold types, except that they are used in combination with sand cores.

Aluminum alloys that may be used for permanent and semi-permanent castings are: 5% Si alloy; No. 12 alloy containing about 8% Cu and 3 Zn; heat treatable 4.5% Cu, 2.5 Si alloy in which iron is limited to 1.1%; heat treatable 5% Si alloy with 1.3 Cu and 0.5 Mg; remainder aluminum and heat treatable 7% Si alloy with 0.4 Mg, remainder aluminum. The last 3 alloys are usually given a solution heat treatment at 960-980 deg. F. for a period to obtain solid solution followed by quenching and aging in hot water.

The furnaces for melting, heated by either gas or oil, hold about 3500 lbs. of metal. Molds of small size have a single gate filled from a single ladle, but large molds have up to 4 gates, at each of which is a separate ladle. When pouring the metal, the mold section must be closed. After removal of the casting, the mold is blown out and cooled. After the cover is set in place and locked, the mold is ready for another pouring.

Small castings, such as an oil filter motor housing having a hexagonal form, require small molds which are operated by hand toggles. The alloy used for this casting is the heat treatable 4.5% Cu, 2.5 Si. The casting is formed over a fixed core.

Frame castings for airplanes do not have to be made to such close tolerances as do engine castings. Often tolerances of 0.010 or even 1/64 in. are permitted.

Mostly automotive parts are made by this process, but electrical parts manufacturers and others are now using it more and more.

—E. G. Fahlman and Herbert Chase, *Iron Age*, Vol. 149, Apr. 23, 1942, pp. 36-42.

Titanium-Deoxidized Cast Steel

Condensed from "The Foundry"

When a moderate amount of aluminum is used as a deoxidizer, low ductility is often encountered. To avoid this, the aluminum may be restricted to a small amount or, more commonly, an excess aluminum is used per ton. The second alternative is more practical, because pin hole porosity is eliminated and the ductility of the steel is better than with a moderate addition of around 1 lb. per ton. With limited aluminum deoxidation, sulphide inclusions separate in a network arrangement, impairing ductility, while with excess aluminum the sulphides occur in globular form.

Tests were conducted in which ferro-carbon-titanium was substituted for part of the excess aluminum, the steel containing 0.26-0.31% C, 0.50-0.61 Mn, 0.26-0.39 Si, about 0.03 P and 0.05 S. After deoxidation with high carbon ferromanganese and 50% ferrosilicon, aluminum up to 3 lbs. per ton and ferro-carbon-titanium up to 10 lbs. per ton were added.

The sulphide distribution was satisfactory in the untreated steel and also in the steel treated with 2-3 lbs. of aluminum. With no aluminum, 7-10 lbs. of ferro-carbon-titanium gave poor results, but with 1 lb. of aluminum these amounts of ferro-carbon-titanium gave the same improvement as increasing the aluminum addition.

With ½ lb. of aluminum, the results were inconsistent. Even 10 lbs. of ferro-carbon-titanium was not enough to bring the sulphide arrangement back to satisfactory condition with only ½ lb. of aluminum. To obtain the same results in regard to sulphide distribution as with 2-3 lbs. of aluminum, about 1 lb. of aluminum and 6 or 7 lbs. of ferro-carbon-titanium should be satisfactory.

Satisfactory sulphide distribution and ductility should be obtainable with average melting practice, using either (1) no aluminum and about 3 or 4 lbs. ferro-carbon-titanium a practice, however, that does not insure against pin hole porosity with green-sand molding; or (2) 1 lb. aluminum and about 7 lbs. ferro-carbon-titanium—which does protect against pin holes.

—*The Foundry*, Vol. 70, April 1942, pp. 135-136, 204-205.

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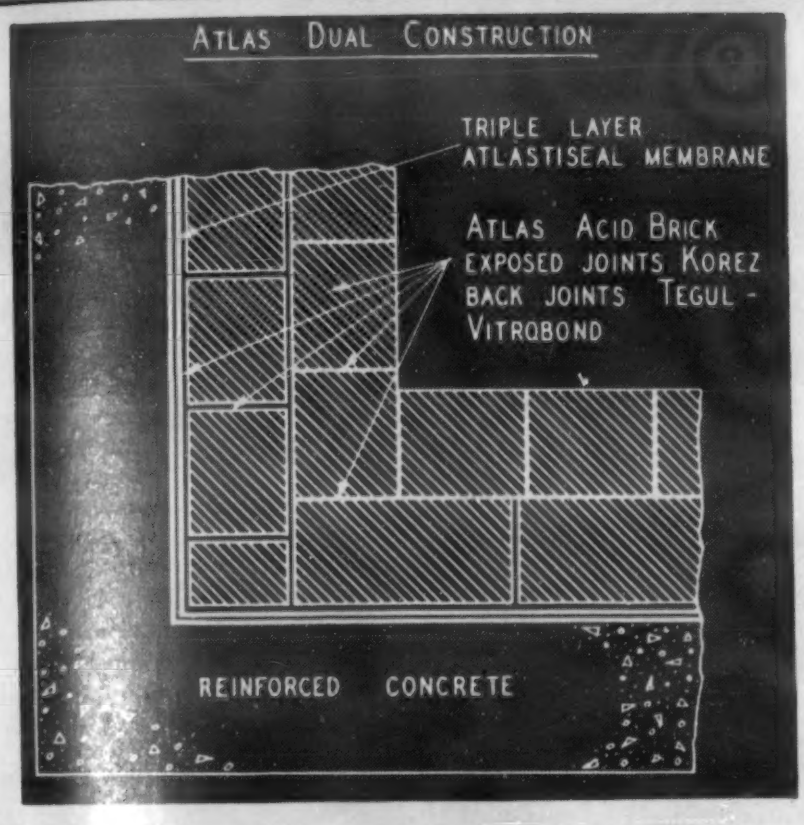
ATLAS DUAL CONSTRUCTION
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ATLAS ACID BRICK EXPOSED JOINTS KOREZ BACK JOINTS TEGUL - VITROBOND
REINFORCED CONCRETE

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3 — ***Carbo*-KOREZ** 4 — **ALKOR** 5 — **VITREX**

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Write for Technical Bulletin TV No. 2A.

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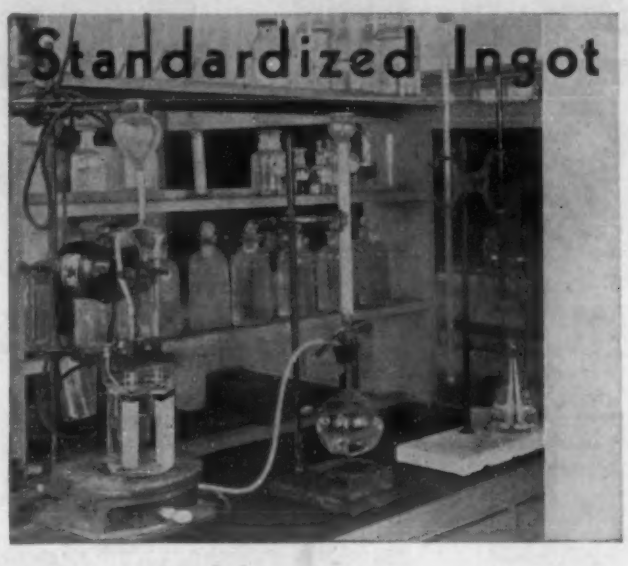

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Its use releases relatively large quantities of tin used in bronze alloys formerly required for such castings.

According to exhaustive laboratory and field reports, this new alloy, known as Ajax "Navy" Tombasil, possesses physical properties far in excess of either Govt. "G" Bronze (88-10-2 and 88-8-4), Spec. 46M6G; or "M" Metal, Spec. 46B8G; as well as the Cu. Si. Alloy known as Spec. 46B28.

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Pot Life in Galvanizing

Condensed from "Steel"

An analysis of the relations between galvanizing pot life and heat transfer in B.t.u. per sq. ft. of heating area for actual installations show that a satisfactory figure for all practical purposes should be a heat transfer of 8,000-10,000 B.t.u. per hr. per sq. ft. of heating area. A pot with a heat transfer of 10,000 B.t.u. per hr. per sq. ft. heating area has a life expectancy of at least 3 yrs., so that any heat transfer below this value is almost certain to give satisfactory pot life.

While about 300,000 B.t.u. are required to melt 1 ton of zinc and about 320,000 B.t.u. to heat the iron up to 900 deg. F., no definite figures can be given for total heat required for galvanizing a ton of steel. These are a function of the kind of article being galvanized, production in lbs. per hr., bath temperature, furnace design, insulation, fuel used, inside or outside bath heating, kind of base metal, size of articles, and whether the work is put through the bath continuously or individually.

Actual operations show that the amount of heat required to galvanize a ton of steel varies widely. A total heat requirement of 375,000 B.t.u. per ton of steel galvanized appears to be the absolute minimum with any fuel or furnace under practical large scale operating conditions.

The average radiation loss when a galvanizing bath is in operation and uncovered is about 5,000 B.t.u. per sq. ft. bath surface per hr. When the bath is idle the temperature is allowed to drop to about 820 deg. F., and if left uncovered, radiation loss is about 4600 B.t.u. per sq. ft. per hr. If the bath is covered when not in use the loss is only 1710 B.t.u. per sq. ft. per hr.—a saving of over 60% at this temperature. Heat losses start to increase rapidly above 850 deg. F.

—Wallace G. Imhoff, *Steel*, Vol. 110, Apr. 27, 1942, pp. 80, 85-86.

Read

"THE PRODUCTION FRONT"

Now a separate department on page 3

War-Production News, Trends, Forecasts

ALUMINUM-MAGNESIUM ALLOYS *Melted-Faster* IN LONGER LASTING TERCOD CRUCIBLES

Tilting type crucible furnace equipped with Tercod Tilting Crucible, size No. 1400, long lip design, pouring into shank-held Tercod Crucible. Aluminum and magnesium alloy foundry of Aluminum Industries, Inc., Cincinnati, O.

IT goes without saying that manufacturers of fighting plane parts are scratching their heads for production shortcuts to beat war quotas.

That's why foundries using tilting type furnaces to melt aluminum-magnesium alloys for light metal castings, prefer Tercod Crucibles. Higher thermal conductivity permits faster melting.

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Straightening Hardened Parts

Condensed from
"Western Machinery & Steel World"

One of the major factors in minimizing distortion is proper support in the furnace; for example, blocks should be used to keep shafts from drooping while heating, and long flat pieces generally warp less when stood edgewise in furnace. Proper manipulation of heating rate is also important.

The amount of pressure to apply in straightening is influenced by grade, cross section, and temperature at the time pressure is applied, so it must be determined mainly by experience. Warpage is decreased if parts of uneven section are quenched so that the heavy section enters the quench first. With some steels, such as high speed steel, the tool can be air-cooled some before oil quenching without appreciable effect on the hardness but with a beneficial effect on warpage.

Air hardening steels can be straightened during the quench. Other steels with fairly high alloy content, such as stainless steel, oil hardening tool steel, SAE alloy steel, high carbon-high chromium steel, and high speed steel can be removed from the quench at temperatures of 400-500 deg. F. and immediately put under the press for straightening without noticeable drop in hardness.

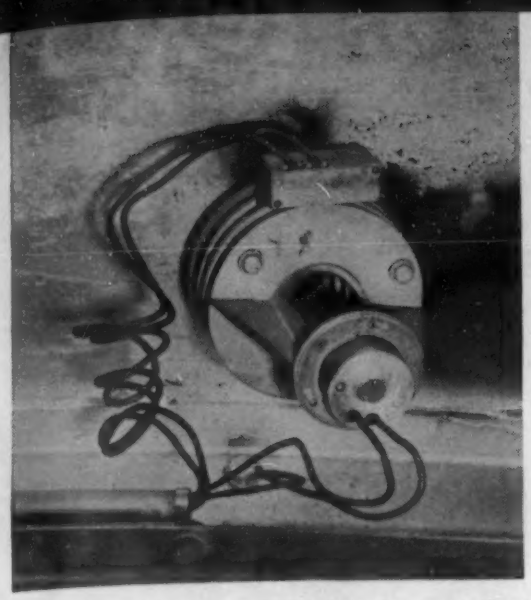
With carburizing steels, core hardness is an important factor; if it is too high, the part will either spring back to its distorted shape when pressure is released or break. One way of avoiding distortion of carburized parts is to drop the box temperature to 1500 deg. F., after carburizing and quench from the box. A more usual means is to cool in the box from the carburizing temperature, normalize, straighten if warping is excessive, remove the scale, harden and straighten.

If the core has under 0.25% C and if the total case thickness does not exceed the total core thickness, the final straightening can be done at room temperature with a screw press. If the per cent of carbon in the core is 0.30 or more, or if the steel is one of the self-hardening types, the part should be removed from the quench with some of the heat left in, and straightened as suggested above for oil-hardening tool steels.

Serious warpage of carburized parts will be encountered if part of the carburized surface is removed before hardening. All sides should either be machined alike, or the machined portion should be recarburized.

One of the newest straightening methods is the use of the acetylene torch for spotting. This is most applicable to straight carbon steels, low alloy steels, and carburized parts with a minimum case depth of 0.32 in. High alloy steels are difficult to straighten by spotting because of the danger of cracking. If no soft spots, however small, can be tolerated, spotting obviously should not be used.

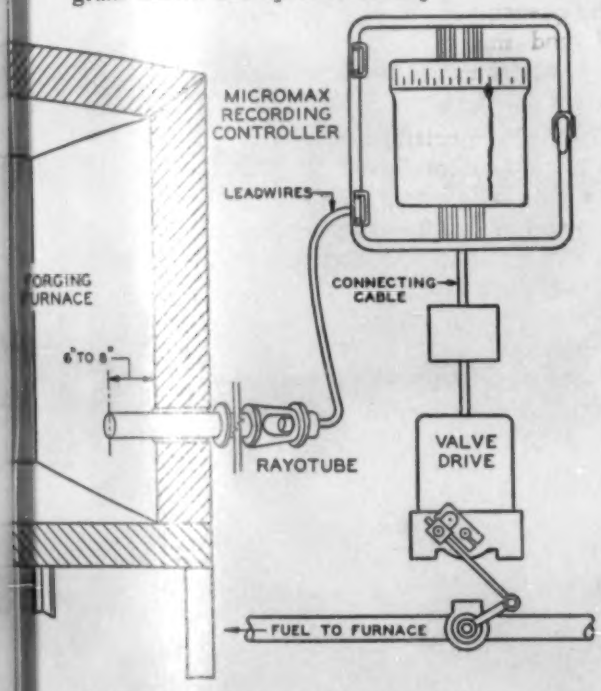
Spotting is always done on the high side of the warp and the flame should be applied at a right angle to the surface. The time of application is usually about one second, after which the torch is rapidly re-



Rayotube installed on a forging furnace, Steel Improvement & Forge Co., Cleveland.

Rayotubes Are Ideal With Micromax Pyrometers for Many Furnace-Control Jobs

Whenever a furnace's pyrometer is using a thermocouple as the temperature-sensitive element, and the couple is not giving satisfactory service, it's a good idea to investigate the use of a Rayotube. For this detector gives greatly superior results in many cases. There isn't space here to give details, but the diagram shows one specific example.



Schematic arrangement of Micromax Controlling Pyrometer, regulating temperature in an oil-fired forging furnace and using a Rayotube to detect temperature. Note that Rayotube proper is outside furnace, merely "looking" in at a closed-end target tube which is at full temperature.

The furnace is one of many, used for the heating of forging stock in the shop of Steel Improvement & Forge Co., Cleveland. Thermocouples, used in these furnaces, used to break because of vibration from the forging hammers. When Rayotubes became available, they were tried, and won on two scores. First, they don't break, burn out, or corrode; they outlast 'couples many times over. Second, they're much more sensitive than 'couples, so that control of temperature is closer, quicker, more accurate.

If you have a problem in which Rayotubes possibly could serve you, see Catalog N-33B, or write us.

This foreman is responsible for annealing of steel, in a plant where annealing furnaces must run for days at an unbroken stretch. He prefers Micromax Pyrometers (on panel behind him), for controlling temperature of the furnaces because they are fully dependable as well as fully automatic; release much of his time for other work.

FOR "ALL-OUT" HELP TO BUSY MEN,

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The Micromax Pyrometers shown above operate for days at a time without the touch of a human hand. They do so because they have, inside themselves, automatic "hands" which attend to routine needs.

Every potentiometer pyrometer, for instance, needs an occasional "standardizing," because its operating cells change in voltage as they are used. So, in Micromax, a gear train performs the standardizing operation, *automatically*. And it does this every 45 minutes—much oftener than a man would; oftener even than is necessary if the operating cells are at their best level of performance. But very new operating cells, or very old ones, or ones which have been frozen, baked or otherwise damaged, have no long-sustained level. So, Micromax takes no chances on any cell. It standardizes so frequently that any one gives good service until it's exhausted.

And, as a cell approaches exhaustion, a signal appears on the pyrometer, calling for attention. Similarly, advance warning is given when fresh chart is going to be needed; or more ink; and if electric power is off, thus stopping the pyrometer, that fact can be seen. And there are many other automatic "hands" in Micromax.

Not all of these features are necessary, or even advisable, for all applications, however, and for that reason we make Micromax in four models, in addition to the Strip-Chart (Model S) shown above. You can thus find a Micromax for almost any furnace-control problem. We'll be glad to help on request, in the selection.

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Here is the most recent example—a real step forward that is still further extending the use of sintered carbides for STEEL CUTTING.

QUALITY IMPROVED—After many years of research on the addition of Titanium to sintered carbides, we offer certain grades of Tungsten-Titanium Carbides that set new performance standards in the machining of steel.

PRICES LOWERED—The wider use of Firthite Tungsten-Titanium Carbides in the TA, T-04, and T-16 Grades has resulted in lower processing costs. TITANIUM, itself, costs less than other ingredients. It is abundantly available from domestic sources. The more of it we use, the less dependent we are on imports of scarce metallic ingredients from foreign countries.

NEW METHOD OF PRICING—Heretofore, in pricing sintered carbides, differences in manufacturing costs have not been recognized. In our new method of pricing, we take into account the foregoing economies—and pass them on to you. (We believe that we are the first in the industry to do this.)

TUNGSTEN-TITANIUM CARBIDE GRADES

PRICES ARE REDUCED ON:

GRADE T-04 — Closest approach to a universal grade. Especially recommended for heavy duty, interrupted cuts, coarse feeds, etc.

GRADE TA — General-purpose material for cutting steel—cast, rolled, and forged. Light, intermittent cuts.

GRADE T-16 — For light, rapid finishing of harder steels.

ABOVE PRICE CHANGES DO NOT APPLY ON:

GRADE T-89
GRADE T-90
These are Tantalum* - Titanium - Tungsten Carbide grades, and are sold for some steel-cutting applications.

*Tantalum is now on the "allocated" scarce materials list.

FOR LATEST PRICES, SEE THESE NEW BULLETINS:

Firth-Sterling
STEEL COMPANY

OFFICES: McKEESPORT, PA. NEW YORK - HARTFORD LOS ANGELES CLEVELAND CHICAGO PHILADELPHIA DAYTON DETROIT

"You can get
die castings like this—
—so why accept the other kind?"

You can get die castings of far greater Density and Strength.

Less than 1% rejects on 100% X-Ray inspection of aircraft die castings—average for a year's production.

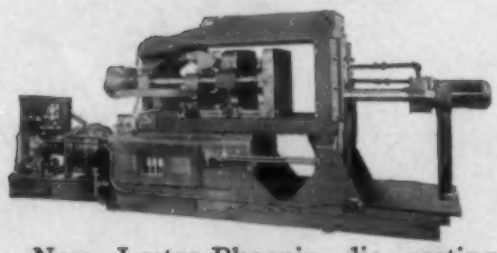
Porosity has ceased to be a hazard. Compare the two photomicrographs, above.

It's **HIGH PRESSURE** that does it!

Die castings are produced at *pressures up to 22,000 lb. psi* in the new Lester-Phoenix machines. (Other so-called high pressure machines have only half this injection pressure; conventional gooseneck machines only about 450 lb. psi.)

Unequalled die closing pressures—400 to 600 tons—are attainable because of the Lester-Phoenix rigid beam type cast steel frame. 360% more frame area for holding the dies closed.

In addition to producing stronger and more uniform die castings, the new Lester-Phoenix machines have greatly reduced flash.



New Lester-Phoenix die casting machine, with non-elastic beam type cast steel frame (no bars to stretch). Die space is directly accessible.

Completely self-contained; no accumulator or compressor required.

Have you read "Sound Die Castings for Aircraft," by Herbert Chase? We'll be glad to send you a copy.

8-page Catalog of Lester-Phoenix high-pressure die casting machines, on request.

SEND US A SAMPLE.
We'll gladly advise—

We'll be glad to tell how your die cast parts can be improved in Density, Strength and Uniformity of Dimension and Quality.

Whether you are buying your die castings or making them in your own plant, *send a sample (or sketches) for our suggestions.* No charge or obligation.

LESTER-PHOENIX, INC.
2715 Church Ave., Cleveland, Ohio

LESTER-PHOENIX
DIE CASTING MACHINES
HIGHER PRESSURES *make* STRONGER CASTINGS

moved and the heated portion cooled with water. Considerable experience is necessary for expert spotting. Shear blades, side broaches, mandrels, arbors and rings are well suited for spotting.

R. B. Seger and G. B. Berlien,
Western Mach'y & Steel World,
Vol. 33, Mar. 1942, pp. 132-135

Making Aluminum Die Castings

Condensed from "The Iron Age"

The Mt. Vernon Die Casting Corp., nominally a manufacturer of zinc-base die castings, has expanded its production facilities, so that war needs for *both* aluminum-base and zinc-base alloys can now be supplied from this plant. The equipment and practice in making the aluminum die castings are particularly interesting.

There are in all 15 machines for making aluminum die castings. These machines are arranged in rows along two walls, with their metal pots toward the walls and the axis of the machine at right angles to the walls. Between the machines are sheet steel screens to guard against metal spitting, and steel benches on which castings are laid to cool after removal from the dies.

Running parallel to the walls near the back ends of the machines are trenches covered with steel plates. In these trenches is all the piping required for hydraulic actuation of dies and goosenecks, low pressure water for die cooling, air for metal injection and gas and oil for heating. There is also a blower line feeding low pressure air to furnaces for combustion.

By having all lines under floor level, space overhead is kept clear for light cranes with chain hoists to move the length of the bays above the machines. This, of course, greatly facilitates handling dies into and out of machines as well as handling goosenecks and other heavy parts of the machines that may have to be removed for servicing.

Nearly all casting is done with Alcoa alloy No. 13, corresponding to ASTM alloy V, which contains 12 per cent Si, the remainder aluminum. A few castings are made with Alcoa alloy No. 85 (ASTM alloy VII), which contains 4 per cent Cu, 5 Si, the remainder aluminum.

Each casting machine has, of course, its own melting pot and the aluminum ingots are delivered to it on skids. Machine operators feed in the already alloyed ingots as required to maintain the proper metal level in the pot.

With virgin ingots are usually mixed some cast from remelted sprues and gates. The conveyor is used only for sprues and gates of No. 13 alloy. As there are relatively few gates and sprues of No. 85 alloy, they are stored and melted separately.

Each machine melting pot is equipped, of course, with a goose-neck-shaped container having a spout which, just before the casting is made, is lifted and locked against the die. Before this, however, the gooseneck is submerged in the molten aluminum in the pot and is thereby filled to the required level.

HEAT TREATING HINTS FREE!

Whether the war has brought you into contact with heat treating for the first time or whether you have devoted a lifetime to it, Heat Treating Hints published without charge for heat treaters, offers you valuable "how-to-do-it" information on heating, quenching, straightening, etc.

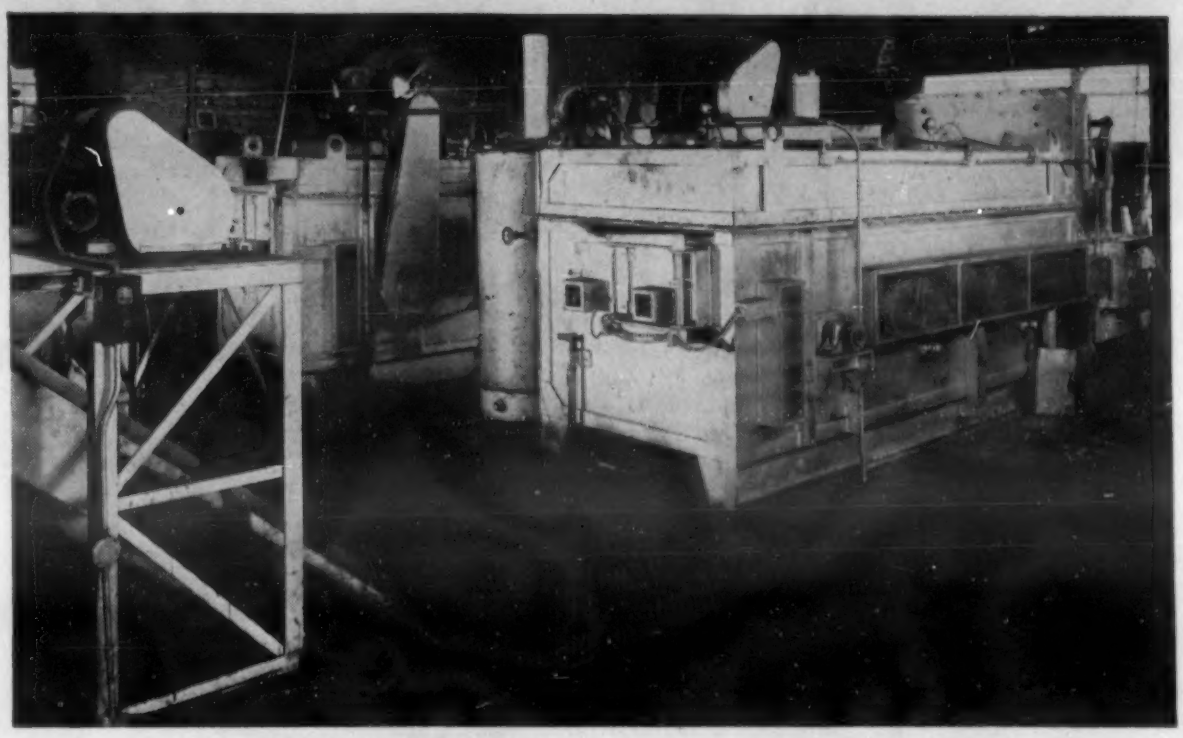
In the third year of its publication, Heat Treating Hints is read and used by over 8000 heat treaters and metallurgists from coast to coast. Your written request will bring you the latest copy and will place your name on the mailing list for future issues. Write today.

MOVIE

Write now to reserve a date for Fall and Winter showings of the full length sound and color Heat Treating Hints movie. Loaned without charge, this film shows actual heat treating operations going on with the editors of Heat Treating Hints at their furnaces, quench tanks and straightening presses. Each operation is thoroughly explained to the satisfaction of the greenest trainee. The film is purely educational and contains no advertising.

To date, the movie has been shown in over 100 cities in the United States and Canada with current bookings to October 1st. For your coming plant or chapter activities, may we suggest that you send today for the pamphlet giving complete instructions on how to arrange for the Heat Treating Hints movie.

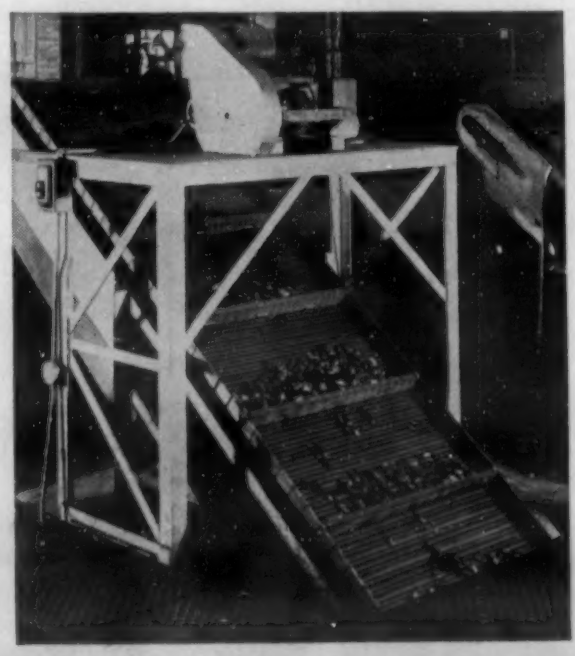
CONTINUOUS CONTROLLED ATMOSPHERE HARDENING



Does the job call for clean hardening? Is the work machined to size before heat treating? Does the job require 400, 600, 700 lbs. per hour? Put the work in a Lindberg Hydryzing Conveyor Furnace for uniform, continuous hardening, without fear of scale, decarb, or carburization. Parts that are machined to size before hardening are held to their original size and extra man hours for pickling, sandblasting, and other cleaning operations are eliminated. In addition, the conveyor furnace requires the attention of only one man. This one man loads the furnace and heat treats, ready for tempering, as much as 1000 lbs. of work per hour.

The work is placed on the heat resistant, controlled speed, conveyor belt, passed through the neutral Hydryzing atmosphere in the heating chamber and automatically quenched by dropping into oil, where the parts come to rest on another conveyor belt which extends up from the bottom of the quench tank. This continuous operation

assures the uniform hardness of each piece throughout the entire job because each piece receives the same amount of heat in the same protective atmosphere.



From the quench tank the parts are discharged into a basket ready for tempering in a Lindberg Cyclone Tempering Furnace. The 100% forced convection heating principle of the Cyclone makes it an ideal furnace for tempering because of its accurate temperature control which assures hardness tolerances of plus or minus 1 Rockwell "C".

Tomorrow's conversion problem does not exist with the Lindberg Hydryzing Conveyor Furnace. Designed as a peacetime furnace for the clean, uniform hardening of springs, bolts, washers and work of similar nature, it is speeding the wartime production of machine gun links, cartridge clips, tank parts and other war products in plants all over the country. For further information on the Hydryzing Process, write for Bulletin 94.

SUPER-CYCLONE HYDRYZING CYCLONE

FOR HARDENING · NORMALIZING · ANNEALING · TEMPERING · NITRIDING

FOR SCALE-FREE AND DECARB-FREE HARDENING

FOR LOW COST, ACCURATE TEMPERING

Above this level there is only a small air chamber, and when the die is closed and locked and the gooseneck is locked to it, air is admitted under a pressure of 450 lbs. per sq. in. to force the metal into the die. After the die is filled, the air pressure is released and the metal pot is again lowered for refilling.

In the latest Mount Vernon machine, the gooseneck is lifted and lowered automatically by hydraulic means as the dies are being closed and opened, but the toggle locking of the gooseneck is done by a hand lever. An interlock is arranged so that the injection air cannot be applied until the die and gooseneck are properly locked.

Dies are opened, closed and locked by toggle mechanism, but the toggles are operated by hydraulic cylinders actuated from a 350 lb. per sq. in. water line pressure. Some of the dies used have hydraulically operated ejectors, but both ejector and cores are commonly operated by hand through rack and pinion.

Automatically actuated slides are arranged to move some cores positively as dies are opened and closed. This is true especially on machines equipped with "unit" dies.

Such unit dies have long been a feature of Mount Vernon equipment. Basically, they include a frame or holder in which die blocks of a standard size are quickly located and locked.

In the case of aluminum casting machines, the frame usually accommodates two separate dies. When a run on one die is completed, another is quickly put in its place. The advantage, of course, is a considerable saving in time, both of operator and machine, since a single machine handles two dies almost as rapidly as if a smaller machine with a single die were used.

There is one cold chamber, high-pressure machine of Mount Vernon design in use. Instead of using a gooseneck and air injection, this machine has a positive plunger designed to inject the metal under a 2200-lb. per sq. in. line pressure.

In this, as in other cold-chamber machines, each charge has to be ladled into the injection cylinder. Before the metal can freeze, the plunger is advanced and forces the charge into the die. The high pressure results in a very dense casting, but casting production is somewhat slower than on gooseneck machines. A unit die is employed in this machine, however, and helps to boost its output of castings.

—Herbert Chase, *Iron Age*, Vol. 149, Mar. 26, 1942, pp. 47-52.

Metallized Soldering Bits

Condensed from "Light Metals"

It has been found that copper soldering "irons" coated, except for the tinned surface, with a diffused aluminum layer have a much longer life than untreated irons. A large part of the benefit thus derived is perhaps due to the enhanced oxidation resistance of the aluminum-rich surface, although its hardness and non-tinning properties are also important.

It is recommended that the aluminum be sprayed on with the wire pistol. After coating, the aluminum is diffused into the copper surface by a suitable heat treatment, often 10-30 min. at 1335 deg. F. Rapid heating to minimize oxidation of the aluminum is recommended. As an additional aid in preventing undue oxidation of the aluminum, painting with a black spirit varnish or black shellac is suggested.

After the diffusion treatment, the area of the bit that is to be tinned is ground back to the desired shape, exposing the bare copper. Since the other surfaces of the bit are non-tinning, such a soldering iron is particularly suited to close work such as in electric instruments where many joints close together are required. Using the diffused aluminum treatment, bits of a very flat and thin shape are practical; without this treatment, such bits would be subject to rapid deterioration.

The use of a mild steel insert in a copper bit has been found useful to minimize wear on the actual soldering surface itself, but full advantage of such a procedure is not obtained unless the copper part is prevented from wear. Hence an ideal bit for many purposes would be one where a steel insert is the only tinned surface, the balance being aluminum-coated or rather aluminum-

How to Save

• TIME

• METAL

• MONEY

making STEEL SHELL CASES

If you contemplate the manufacture of steel shell cases, here are two ACP Products that will be of interest to you.

An immersion in ACP's CUPRODINE produces a dense, adherent coating of copper which substantially reduces wear on dies, cuts time over the electrolytic method, saves plating equipment, bus bars and copper electrodes.

ACP also offers—from its war-to-war experience in metal treatment and finishing—RODINE, the inhibitor used in pickling after annealing, which produces a smooth pickled surface and minimizes embrittlement. In severe draws, this latter is of great importance.

•

Other ACP Products that contribute to the war effort are: DEOXIDINE to prepare steel, aluminum and dural for painting; LITHOFORM for coating galvanized iron to hold paint; FLOSOL, an exceptional soldering flux; KEMICK for protecting metal surfaces even when heated red-hot, and other special chemicals vital to the better, cheaper, faster finishing of metals.

Whether or not there is an ACP Product available for your needs, you are invited to bring your problems here for study and recommendations on the proper chemicals and process to help you meet today's requirements. Write today outlining your problems.

AMERICAN CHEMICAL PAINT CO.

MAIN OFFICE AND WORKS
AMBLER . . . PENNA

ACP

CHEMICALS ACP PROCESSES

DETROIT, MICH., 6335 Palmer Ave., E.
CANADIAN BRANCH
WALKERVILLE . . . ONT

Courtesy The Jacobs Manufacturing Co., Hartford, Conn.

HARDEN 700 PER HOUR

with this new heat-treating process!

● Heat-treating outputs are being multiplied two-fold, three-fold and more by TOCCO—the new simplified electric induction heat-treating process! In fact, output of the drill chuck part shown above *was multiplied seven-fold!*

Where former methods required many man-hours, several operations and much scattered equipment, the TOCCO machine performs the complete hardening operation in *a matter of seconds*—with a push-button start and automatic precision control. *Doesn't require skilled labor.*

Where former methods heat-treated the whole part, TOCCO *localizes hardening* at the wearing surface—keeps the core tough—minimizes distortion, *eliminates straightening and rejects.*

Can be installed in assembly line because it is so cool, clean and compact (only 7 ft. x 5 ft., maximum).

For post-war production, too. Just change work fixture to adapt to peacetime products.

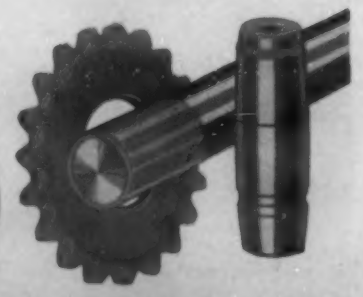
See how TOCCO can *speed up* and *improve* your output!

THE OHIO CRANKSHAFT COMPANY
Cleveland, Ohio

SPEEDY ELECTRIC HEAT IS GENERATED WITHIN THE SECTION TO BE HEAT-TREATED

TOCCO

World's Fastest, Most Accurate Heat-Treating Process



diffused copper. While the copper is not the working member, it still is important as a means of obtaining rapid conduction of heat to the "iron," where the "iron" is iron in fact.

—*Light Metals*,
Vol. 5, May 1942, pp. 145-148

Stored-Energy Aluminum-Welding

Condensed from "American Machinist"

One of the latest resistance welding methods for high conductivity metals is the process based on storing energy either in a transformer or capacitor and suddenly discharging it to produce a quality weld. Used generally in the welding of aluminum alloys in the aircraft industry, this new process gives more uniform welds with better surface, but with a peak power demand only about one fourth that required by an equivalent a.c. spot welder.

The electromagnetic method operates from an a.c. supply line, but it is a d.c. process, employing d.c. obtained from an ignition rectifier. After the material has been positioned between the electrodes, an electrode pressure is applied; then, the welding transformer is charged with d.c. current from the ignition rectifier thus providing the heat for welding.

During the fall or decay of this current, the electrode pressure is suddenly increased and held there until the heat period is completed and the material has fused. This increased pressure at the end of the welding gives a mechanical working of the metal which compensates for the changes in grain structure caused by the fusion heat.

The electrostatic method also operates from a.c., but the energy is stored in a capacitor rather than in a transformer. After the material is placed between the electrodes and heavy pressure applied to the capacitor, the energy is discharged into the welding transformers with a welding current which is adjustable as to crest, rate of rise, and time duration.

The stored energy method is better than the ordinary spot welder for alloys with high thermal conductivity because the weld is produced almost instantaneously before any of the heat can be conducted away.

—C. E. Smith, *Am. Machinist*,
Vol. 86, Apr. 30, 1942, pp. 375-378.

Direct Mounted Car Drives for Convenience and Safety
Do you have to wait until your crane is free before you can move your furnace cars? Do you have a winch taking up valuable floor space and cables stretched across the floor which create a safety hazard?
R-S furnace cars can be furnished *electrically operated* with drive mounted directly on the car. Merely plug in a cable, push a button and the car moves smoothly. The only limit to length of travel is the length of cable.
The broad experience of R-S in the designing and operation of industrial furnaces can help you *now*. Draw upon it for complete satisfaction in your metallurgical heating processes.
R-S PRODUCTS CORPORATION
4522 Germantown Ave.
Philadelphia, Pa.
QUALITY PRODUCTS SINCE 1908
R-S Furnaces of Distinction
BUY WAR BONDS

Nickel Plating Magnesium Alloys

Condensed from
"Transactions," Electrochemical Society

Several difficult problems have prevented the development of a successful technique for the electroplating of metals on magnesium and its alloys. The chief difficulty is probably due to the formation of a film of magnesium hydroxide on the surface. A further difficulty is the fact that non-adherent immersion deposits form on magnesium in most plating baths.

The following procedure, in which a nickel fluoborate bath is used, overcomes the above difficulties and gives excellent deposits with good adhesion:

1. Buff the magnesium and degrease in a solvent such as perchlorethylene.

2. Cathodic clean. The cleaner formula is:

Sodium carbonate decahydrate	7.4 oz./gal.
Trisodium phosphate	14.5 oz./gal.
Sodium hydroxide	3.7 oz./gal.
Sodium metasilicate	7.4 oz./gal.
Sodium lauryl sulfate	0.9 oz./gal.

Time—1 min.; Current density—50 amp./sq. ft.; Temp.—158 to 194 deg. F.

3. Wash with hot and then with cold water.

4. Chrome-pickle etch. The etching bath contains:

Chromic anhydride, C.P.	15.8 oz./gal.
Nitric acid, C.P.	10.4 oz./gal.
Sulfuric acid, C. P.	0.007 oz./gal.

Time—5 sec.; Temp.—room.

5. Wash with cold water.

6. Dip in modifying acid dip, which contains:

Hydrofluoric acid (52% HF)	22 oz./gal.
Nitric acid, C.P.	1.1 oz./gal

Time—2 to 5 min.; Temp.—room.

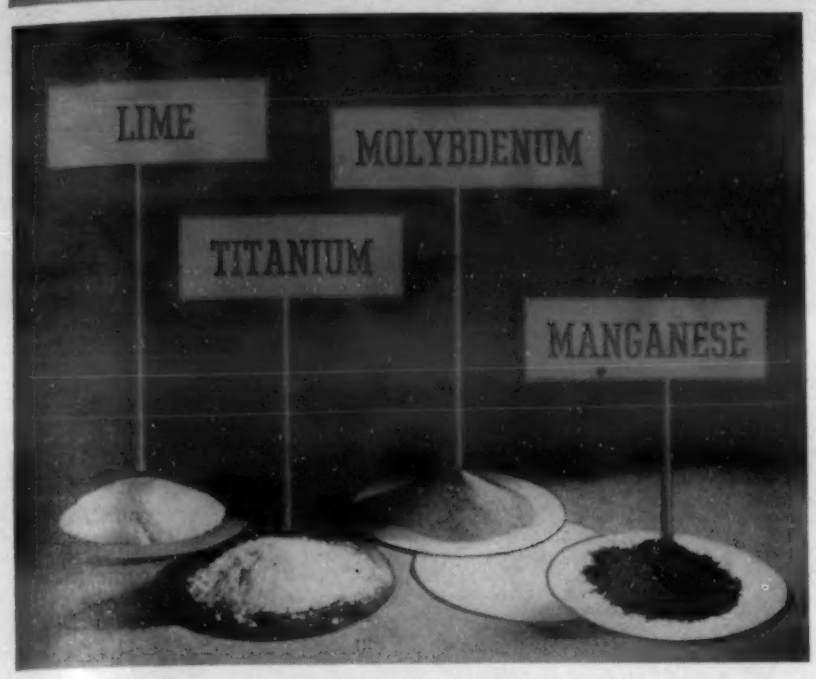
7. Wash with cold water.

8. Nickel plate. The bath contains:

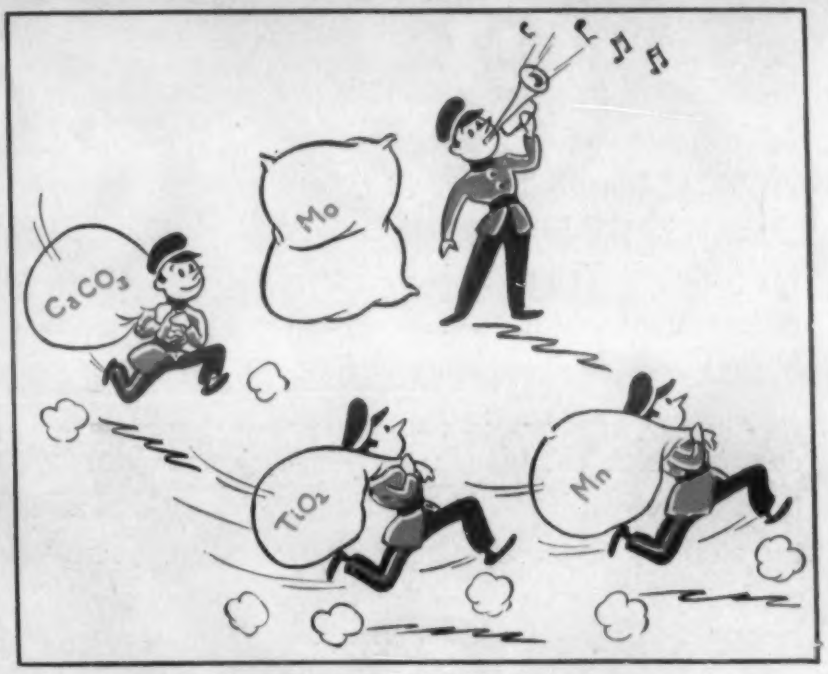
Nickel sulfate ($NiSO_4 \cdot 6H_2O$)	7.9 oz to 9 oz./gal.
Boric acid	4.6 oz./gal.
Ammonium fluoride	8.8 oz./gal.
Hydrofluoric acid (52% HF)	to reduce pH to 5.5
Duponol ME (wetting agent)	0.004 oz./gal.

Temp.—102° F., Current density—10 to 30 amp./sq. ft.

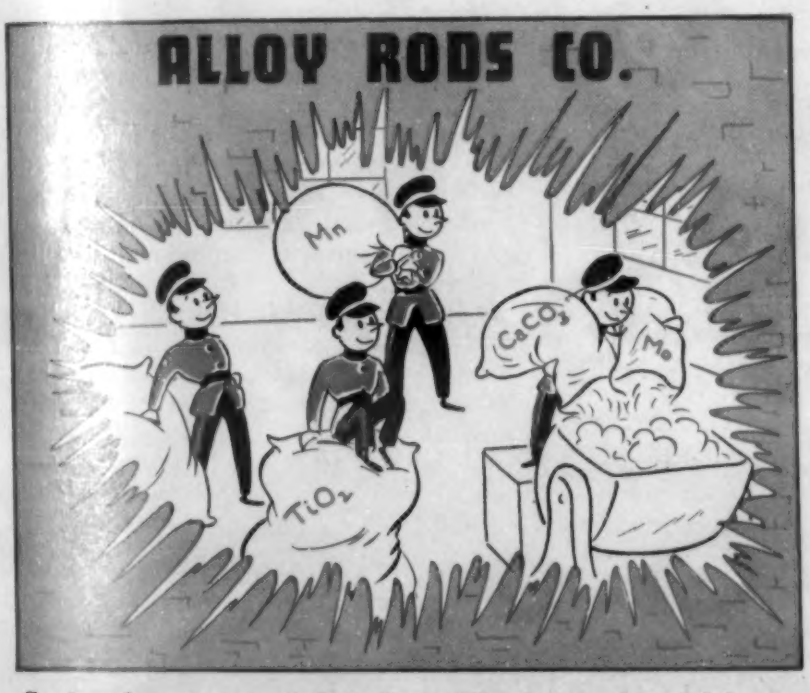
A WELD-E-MENTARY TALE



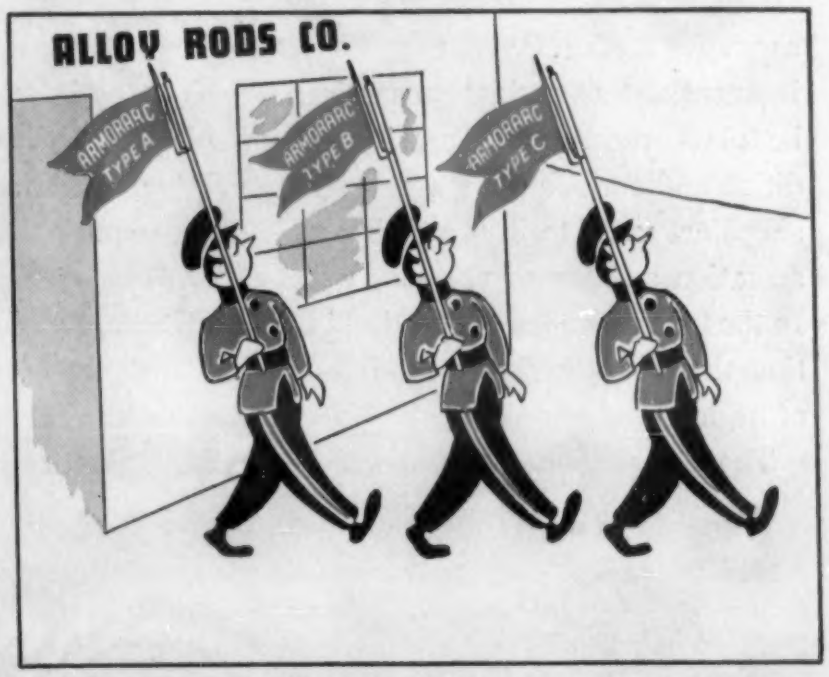
The four heroes of this tale are the elements Titanium, Manganese, Lime, Molybdenum. When they're relaxed and idle, they look like this. But, now is no time to be relaxed and idle. They have a big job to do . . . and they're ready to do it.



Ta-ra-ta-ta! Call to arms . . . and our heroes are off to their induction center at Alloy Rods Company. Because it's *M-Day* for the welding industry, and super-Mobilization Day for these guys; really the power behind the spark in armor plate welding.

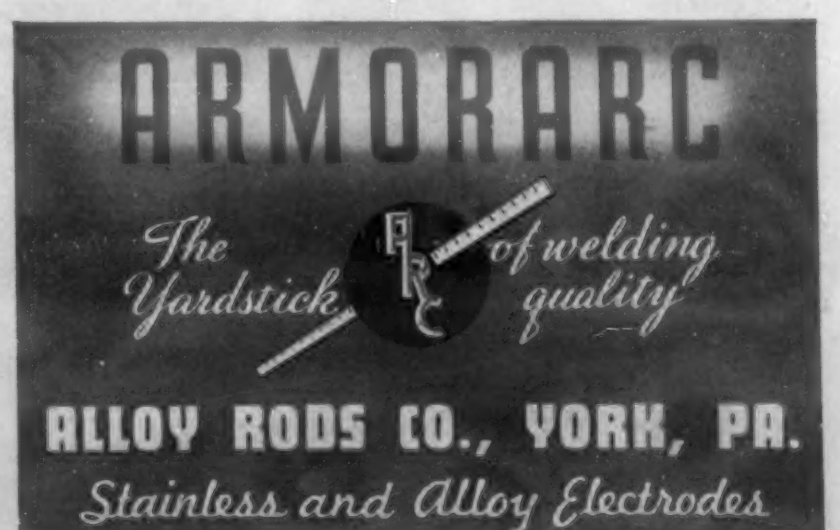


Getting the mixture of their lives. Titanium and Molybdenum get together, form the coating supreme for Armorarc Type A. Titanium also mixes with Manganese, comes out as the coating for Armorarc Type B. Lime and Manganese make up Armorarc Type C's coating. Quite a crowd, this Armorarc family . . . eh!



Hep, hep, hep . . . look out, Adolf! You too, Mister Jap! Our heroes really can brag about the "coats of arms" of the toughest bunch of electrodes for armor plate welding you ever saw. Three cheers for Titanium, Manganese, Lime, Molybdenum—elements which turn into *weld-e-ments* for Armorarc's coating.

ON THE ARMOR PLATE PRODUCTION FRONT
ARMORARC TYPE A
(Titanium and Molybdenum)
ARMORARC TYPE B
(Titanium and Manganese)
ARMORARC TYPE C
(Lime and Manganese)
In all ready-for-action Armorarc stainless electrodes, there is no stub loss due to cracked coating. Armorarc assures the welder of low splatter loss . . . easily removed slag . . . welds that do not crack.



Conserving Nickel and Chromium Through Proper Care

Heat resistant alloys are indispensable in many of our war production processes, because they resist oxidation and retain their strength at high temperatures definitely better than other commercial metals. Nevertheless, regardless of who makes them, they are metals which expand and contract with changes in temperature. They can be overheated and, therefore, with proper care, can be made to last longer.

Nickel and chromium, which are the major constituents of these alloys, are critical materials in our Victory program and the supply is limited. Also, they are relatively expensive metals. Obviously, then it is essential that special precautions be taken concerning the service condition under which the heat resistant alloys are used, to insure their conservation and for economy as well. In the fever of high pressure production there is always the possibility of neglect and abuse.

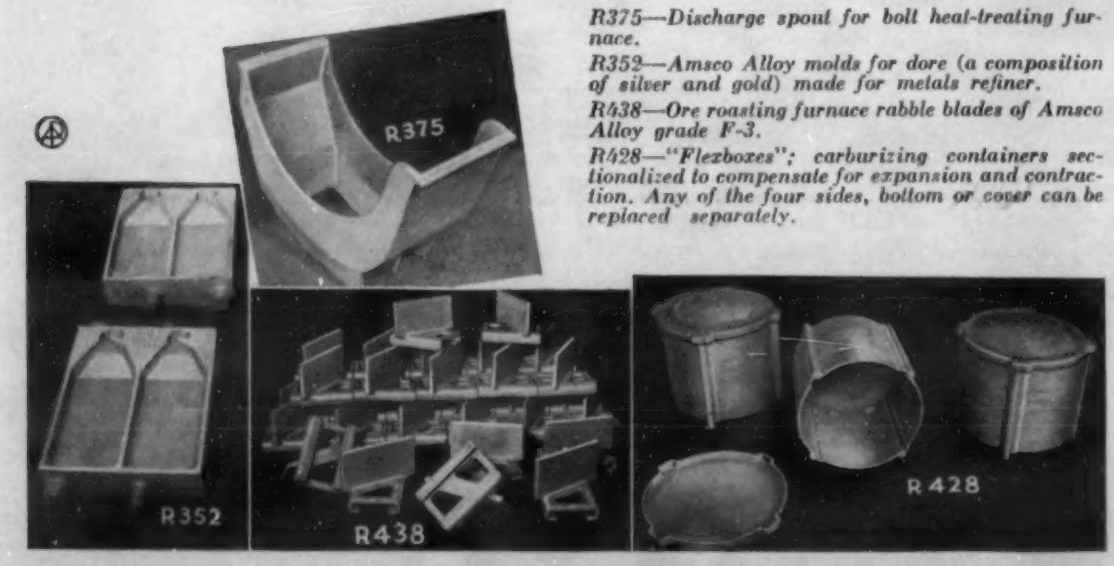
The following safeguards therefore should be very carefully observed:

1. Avoid overheating.
2. Avoid localized or uneven heating.
3. Regulate changes in temperature as much as process will permit.

Use of the proper analysis for the job is vitally important and Amsco, through its metallurgical and physical research laboratories, can aid materially in the selection, and through its engineers, help develop proper designs that take into consideration thermal stresses, shape of parts to be heat-treated and other pertinent factors.

Amsco Alloy is serving production for Victory in many plants employing heating, heat-treating, roasting, refining, calcining and other processes requiring high temperatures and involving corrosion.

Bulletin 108 describes the standard analyses of Amsco Alloy and pictures typical heat and corrosion resistant castings for industry.



R375—Discharge spout for bolt heat-treating furnace.
R352—Amsco Alloy molds for dore (a composition of silver and gold) made for metals refiner.
R438—Ore roasting furnace rabble blades of Amsco Alloy grade F-3.
R428—"Flexboxes"; carburizing containers sectionalized to compensate for expansion and contraction. Any of the four sides, bottom or cover can be replaced separately.

Amsco
AMERICAN MANGANESE STEEL DIVISION
OF THE AMERICAN BRAKE SHOE & FOUNDRY CO.
Chicago Heights, Illinois

Manganese Steel Castings for shocks and abrasion.
Chromium-Nickel Alloy Castings for heat and corrosion resistance.
Power Shovel Dippers. Dredge and Industrial Pumps.
Welding Materials for reclamation and hard-surfacing.

FOUNDRIES AT CHICAGO HEIGHTS, ILL.; NEW CASTLE, DEL.; DENVER, COLO.; OAKLAND, CALIF.; LOS ANGELES, CALIF.; ST. LOUIS, MO. OFFICES IN PRINCIPAL CITIES

The nickel bath to give best results should have an analysis as follows:

Nickel, 1.77 oz./gal.; boron (total), 0.80 oz./gal.; fluorine (total), 6.58 oz./gal.; excess boron, 0.158 oz./gal.; excess fluorine, 0.8 ± 0.1 oz./gal. "Excess boron" is the amount above that required to combine with the nickel as $Ni(BF_4)_2$. "Excess fluorine" is the amount above that required to react with the boron present to form BF_4 ions.

In making up the nickel bath it has been found best to dissolve the ammonium flouride and boric acid first. The pH is then reduced to about 5.8 to 6.0 with hydrofluoric acid, followed by addition of nickel sulfate. Final pH adjustment is then made with hydrofluoric acid.

Cleaning conditions and type of cleaner are not critical; any good alkaline cleaner may be satisfactory. In the chrome pickle, commercial chromic acid may be used if its sulfate content is taken into account.

The two-step acid pretreatment apparently serves 2 purposes. The chrome pickle removes the magnesium oxide normally present, replacing it with a film of chromium oxide. In the fluoride dip this film is modified or perhaps replaced by a magnesium fluoride film that is compatible with the nickel from the nickel-fluorine type of bath. It may be that this film is entirely removed in the nickel bath.

Anode and cathode efficiencies are high and approximately equal. Two difficulties have been encountered in the operation of this bath: (1) nickel fluoride tends to precipitate from the bath while in use, (2) it is difficult to maintain the pH due to poor buffering of the solution. The adhesion is good enough so that on attempts to lift the deposit the failure occurs in the magnesium.

The deposits may be readily buffed to a high finish and chromium plated. They stand up well in indoor atmospheres, but are not recommended for moist corrosive conditions.

—W. S. Loose, *Trans. Electrochem. Soc.* (Preprint), Vol. 81, 1942, 17 pp.

Power Requirements in Machining

Condensed from "Automotive Industries"

Forces developed by the cutter of a machine tool and power requirements in metal-cutting operations are of importance in connection with the selection of the size of motor for the machine tool and in the design of the power transmission from the motor to the cutting tool and the feed transmission mechanism.

They also serve as the basis for the determination of stresses and deflections of the frame and other parts of the machine tool and for the selection of the proper size of cutting tool. Finally, they constitute one of the important factors governing the design of jigs, fixtures and special tools for holding the work in machining operations.

The power requirements in various metal-cutting operations were obtained, such as turning, milling, drilling, planing, etc. From these data the general conclusions may

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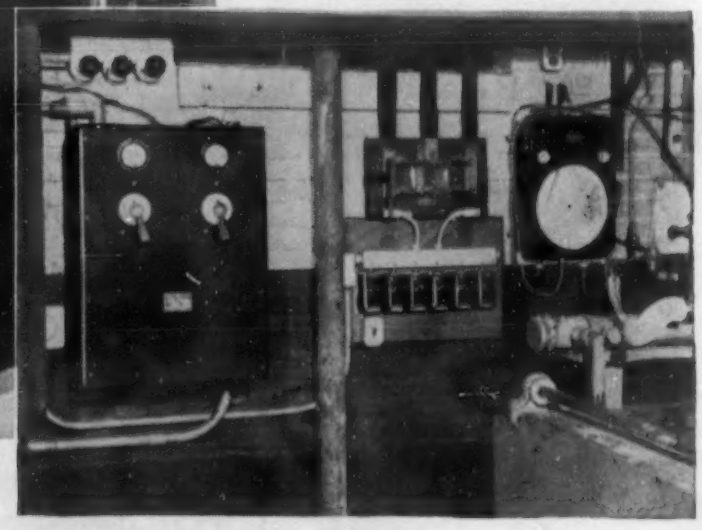

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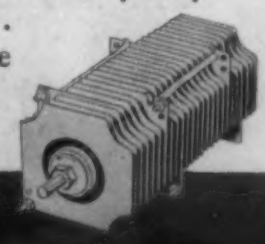

GENERAL ELECTRIC

be drawn that the quotient of the horsepower developed at the cutter by the cubic inches of metal removed per minute—called the net horsepower per cu. in. per min.—is approximately 1.0 for steel and 0.60 for cast iron. The gross power—that is, the power developed by the motor—per cu. in. of metal cut per min. will average about 2.5 for steel and 1.2 for cast iron.

These values will vary over a considerable range, however, depending upon the specific operation performed, the machine tool, the shape of the tool, the cutting speed, and the particular metal being machined. For magnesium alloy, the horsepower per cu. in. of metal planed per min. is 0.12.

The value increases for a wide variety of non-ferrous metals up to about 0.6 for cast iron and malleable cast iron, and then ranges from 0.75 to 0.92 for steels. It is just below 1.0 for annealed copper, and increases to a maximum value of 1.7 for Monel metal.

On the same chart similar values are given for specific conditions for drilling and milling. These values, however, are uniformly higher than those for planing, as might be expected.

If the rake of the tool or the size of cut is changed, the above values are altered. They are reduced in almost direct proportion to an increase in rake angles. They are increased if the feed or the thickness of the chip is reduced. In nearly all metal-cutting processes the cutting force is practically independent of the cutting speed above 10 or 20 ft. per min. The over-all efficiency of the average milling machine is low, ranging from 20 to 50 per cent. Curves show that the lowest value of horsepower per cu. in. of metal cut per min. is obtained for the largest feed and the largest depth of cut.

Likewise, in drilling, the efficiency of the machine, as determined by dividing the input by the output, is highest when using small drills operating at high speed with resulting low values of torque and thrust. Similarly, the efficiency is lowest when the torque and thrust are high, even though the speed of the machine is low.

It has been found that torque and thrust are only slightly affected by a change in cutting speed. The power, however, is a direct function of the speed.

The net horsepower per cu. in. of metal cut per min. is lower the larger the feed and the drill diameter. In drilling S.A.E. 6150 steel with a ½-in. drill at 0.009 in. feed, a value of 1.443 is obtained. In drilling the same steel with a 1¼-in. diam. drill at 0.015-in. feed, the horsepower per cubic in. per min. is 1.075. For cast iron, these values are 0.605 and 0.493, respectively.

—O. W. Boston, *Automotive & Aviation Inds.*, Vol. 86, May 15, 1942, pp. 30-34.

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Heat Treating Bolts

Condensed from "The Iron Age"

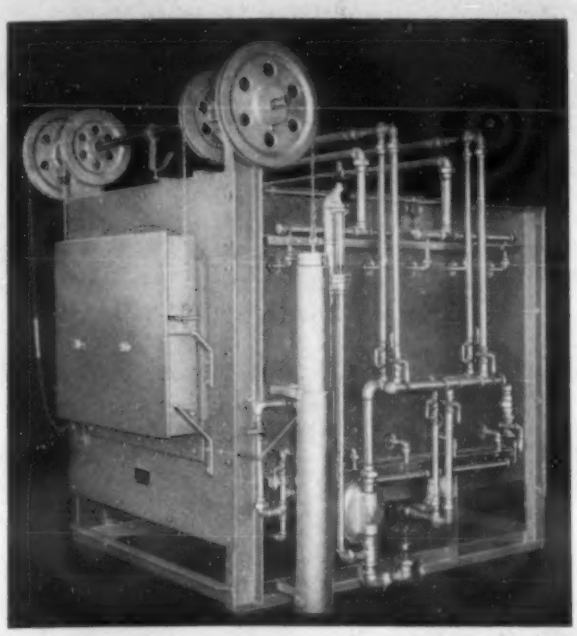
The easiest way to increase the strength of hot-formed bolts is to increase the carbon content and, secondly, the manganese content. Beyond that, physical properties will vary, depending upon the austenitic grain size and cooling rates used.

The common method of making bolts is cold heading, using cold-drawn low-carbon or medium-carbon wire. Basic open-hearth, semi-killed steel conforming to A.I.S.I. specification C 10118 is the most commonly used. After cold heading, the bolts are given an anneal to return some degree of plasticity to the high-cold-worked head.

Steel for medium-carbon bolts contains 0.30-0.45% C, 0.60-0.90 Mn, and 0.10-0.30 Si. The medium carbon wire is usually annealed before cold drawing either above 1650-1700 deg. F. or below the critical range (1200-1300 deg. F.). The first treatment produces a pearlitic, and the second a spheroidized, structure.

Maximum physical properties are obtained by hardening the cross-section of bolt in quenching operation. Heat treating temperature of medium-carbon bolts is 1550 deg. F. Amount of decarburization on the wire must be controlled within 0.008 in. maximum totally decarburized, and 0.015 in. maximum total and partial decarburization. Quenching must be such as to bring complete cross section to a hardness of 50 to 55 Rockwell C.

In the absence of a tensile testing machine, bolts are often inspected by hardness tests. Medium carbon steel bolt will have a Rockwell C hardness of 22 to 32. Readings are preferably taken on threaded end. Readings on the top of the head will



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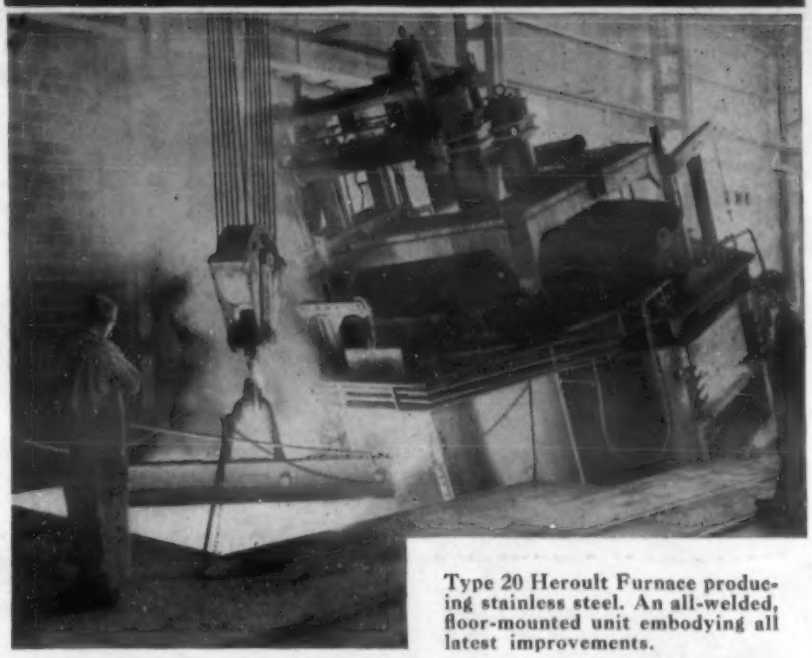

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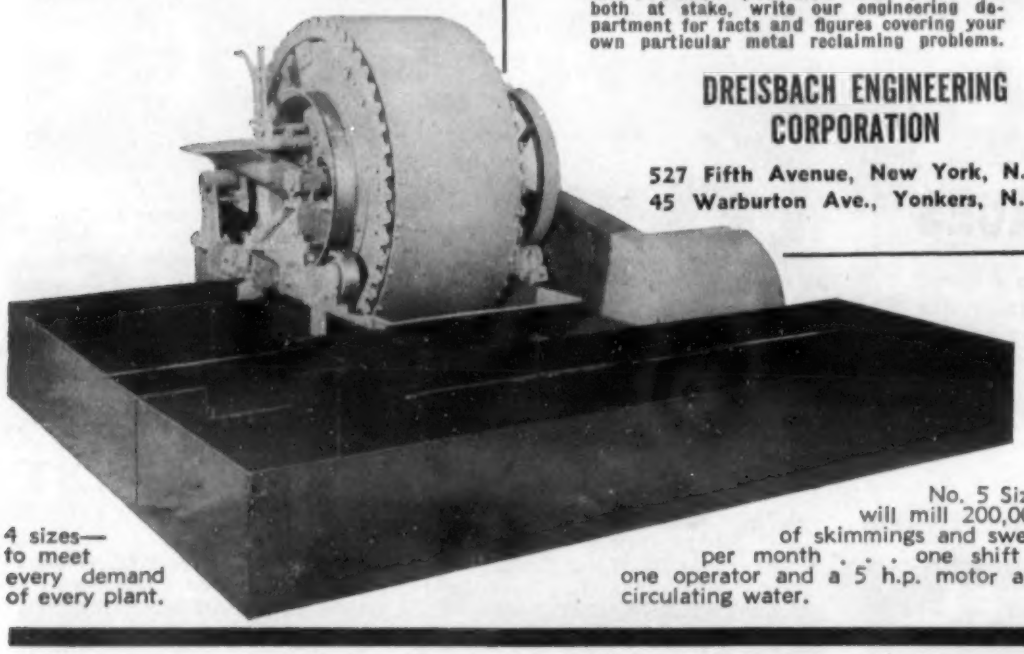

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wrought brass samples showed that in all cases cracks in the coating began at cold work points and followed lines of cold work operations such as drawing, swaging, etc.

The latter observation suggested that experiments be made on annealed specimens. Chromium plated and annealed samples of high zinc brass tubing showed no cracks with outdoor exposure after 8 months. The usual result of the formation of small pin-point pits which expose the base metal has occurred.

The author concludes that cast high copper brass may be directly chromium-plated with reasonably good results (in terms of present day shortages) and that the annealing of high zinc wrought brass parts after chromium plating has a definitely advantageous effect on adhesion of the plate.

—R. B. Eyre, *Metal Finishing*, Vol. 40, Apr. 1942, pp. 192-199.

Brazing of Small Assemblies

Condensed from "Sheet Metal Industries"

Brazing may be carried out with a torch, furnace, electric resistance, dip, salt bath or forge. Practically all ferrous and non-ferrous metals and alloys can be brazed satisfactorily with the exception of aluminum, zinc and magnesium alloys (however, recent advances have been made in the U.S.A. in the furnace brazing of aluminum and some of its alloys, using aluminum-silicon alloys as brazing materials).

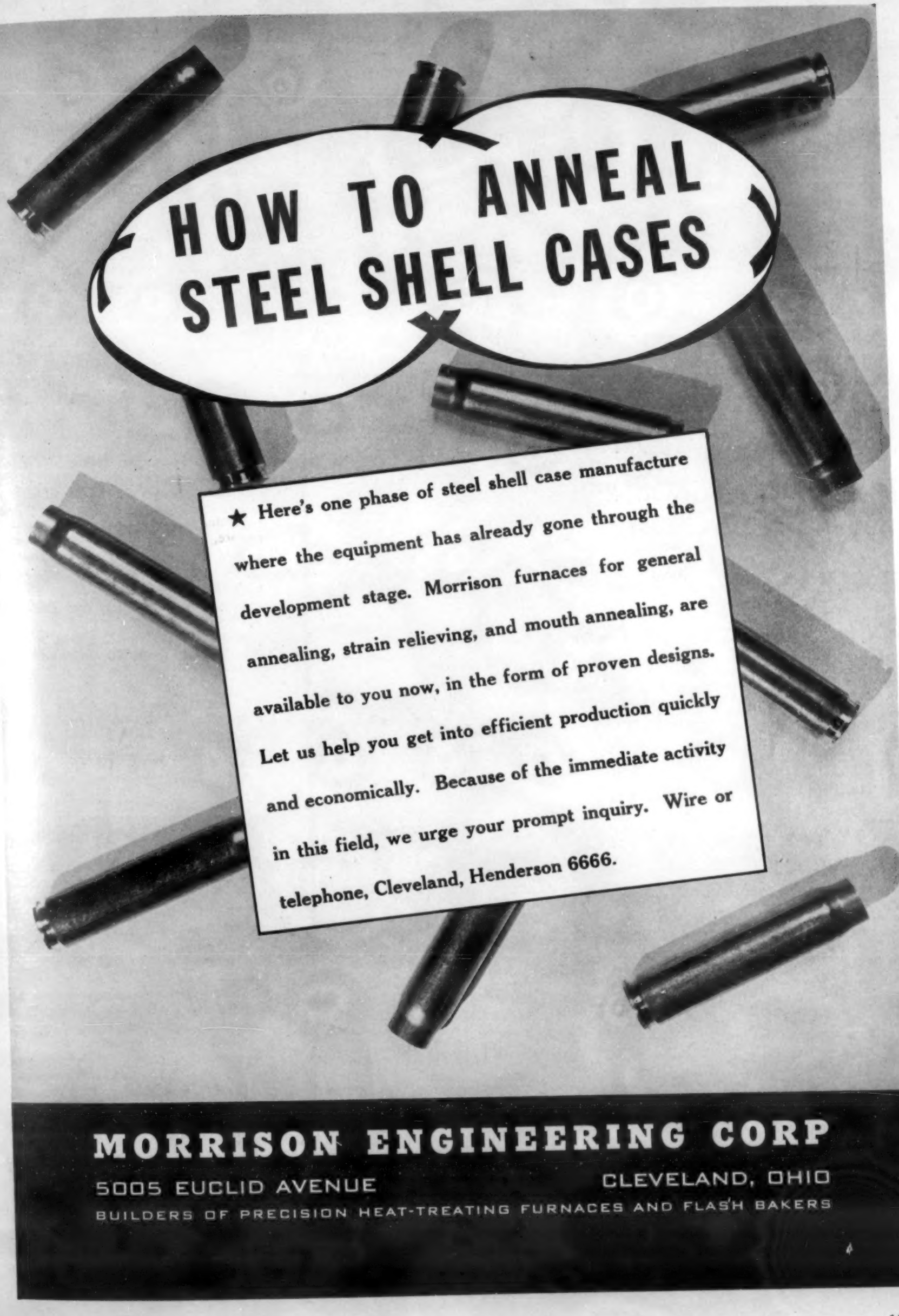
Brazing alloys include brasses (melting range 1550-1750 deg. F.), silver alloys (melting range 1100-1550 deg. F.), copper-phosphorus and copper-silver-phosphorus alloys (melting range 1275-1380 deg. F.) and copper (melting point 1982 deg. F.). Brasses are used principally for ferrous metals where brazing at a fairly high temperature is permissible and where "finishing" processes are permissible. Silver alloys are used for all types of metals where a low brazing temperature is desirable and joint strength and ductility with a clean finish are required.

Copper-phosphorus and copper-silver-phosphorus alloys are used for copper and copper-rich alloys where strength but little ductility is called for. Copper is used mainly for mild steel brazed in reducing atmosphere furnaces.

Borax-type fluxes are used for temperatures above 1375 deg. F., fluoride fluxes for lower temperatures. Fluxes are unnecessary in the copper brazing of mild steel in controlled atmosphere furnaces, for the joining of copper components with a phosphorus-bearing brazing alloy, and for resistance-brazing operations where a jet of hydrogen is played on the joint.

It is important that all of the opposed surfaces of the parts to be joined are wetted by the brazing alloy and that there are no flux or gas inclusions. Optimum clearances depend on the type of joint; distance brazing alloy must travel by capillarity, metals involved, possibility of alloying, etc.

—H. R. Brooker, *Sheet Metal Inds.*, Vol. 16, May 1942, pp. 669-676.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Centrifugal Castings in Design

Condensed from "Machine Design"

Centrifugal casting, as one of the fabricating processes available to the engineer, is often overlooked in respect to the production of machine parts. The process consists in rotating a sand-lined or permanent metal mold at speeds ranging from 600 to 2,000 r.p.m., while molten metal is poured into the mold. The metal solidifies as it is forced against the walls by centrifugal force.

The basic shape produced is a tube, either thin or thick walled. Gear blanks, cylinder liners, pipes, brake drums, bearings, rolls, annular rings, valves, etc. thus lend themselves to fabrication by this process, but the hollow bore of such castings must be a uniform cylinder. The external surface, however, need not be cylindrical; hexagons, squares, etc. are obtainable.

Design Considerations

Outwardly extending flanges of a thickness not much greater than the wall of the tube can be produced. External flanges or protuberances should be located only at one end; if placed at both ends, normal shrinkage of the casting would be hindered, and wall-stresses with eventual cracking might result.

This design limitation can be circumvented by casting one flange separately and then welding it to the main body of the cylinder. It is often economical to machine out, rather than to cast, end contours.

Satisfactory operation of the casting machine requires that the casting be dynamically balanced. Therefore, if large holes are required in the casting in locations such that they would lead to dynamic unbalance, the part is cast solid and the holes machined out later.

The size limitations of centrifugal casting are more than adequate. Diameters of parts may approach 50 in., and lengths up to 300 in. are entirely possible.

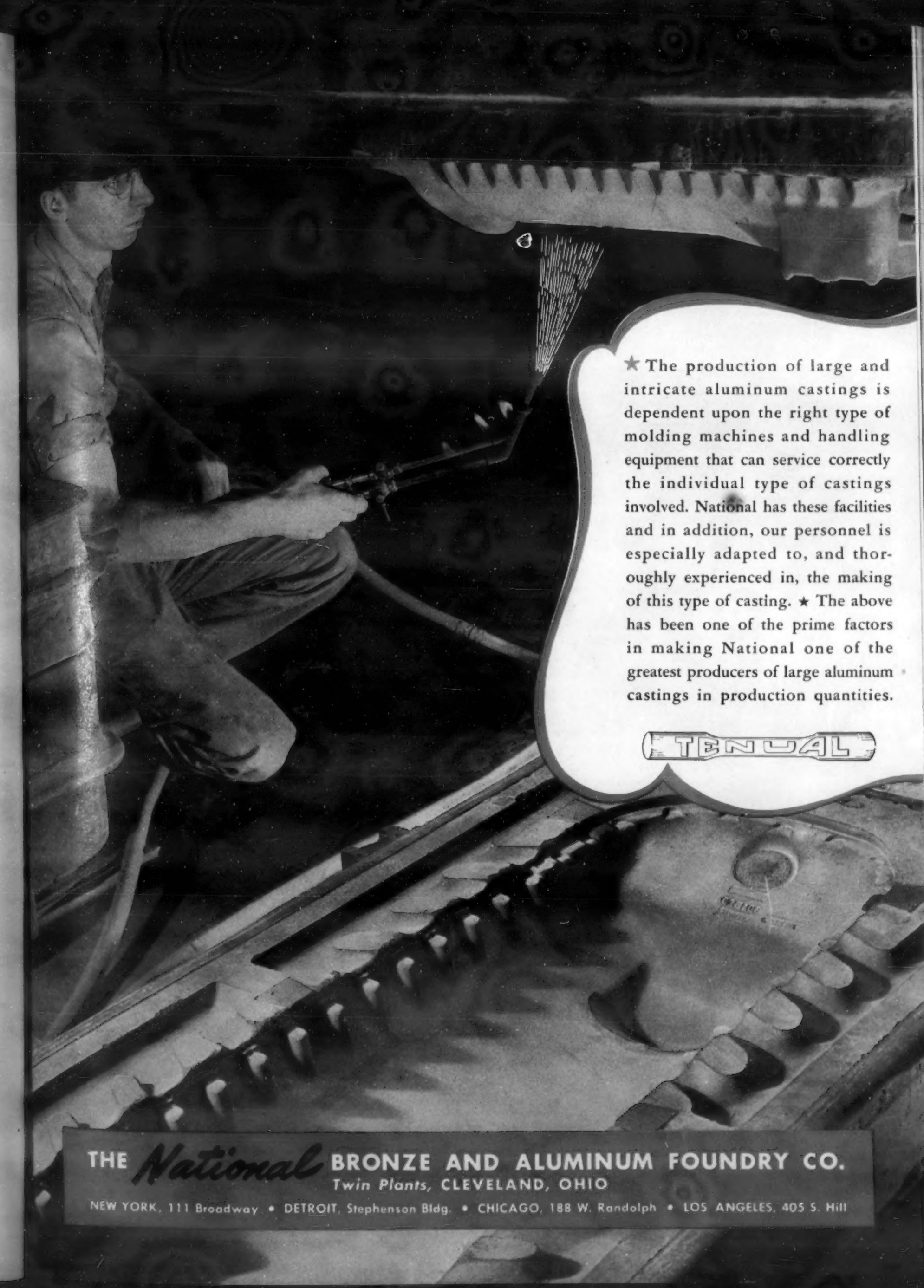
Small allowances—from 1/16 in. up to ¼ in.—must be made for finishing. Finishing allowances must be greater for inside surfaces, since it is along such surfaces, as cast, that the inclusions, oxides, etc. are found.

Because of their improved metallurgical structure, centrifugal castings may have strengths 20 per cent greater than those of similar parts conventionally cast. Elongation may be 30 per cent greater, and hardness slightly improved.

Some work of potential value has been done on the production of irregularly-shaped machine parts by rotating the mold about more than one axis. Wall thicknesses of hollow objects so made can be closely controlled, and notable savings in weight over solid parts achieved.

Materials Used

Navy bronze 46M6f (7.5-11 per cent Sn, 1.5-4.5 Zn) centrifugal castings are employed for bearings, shaft sleeves, etc. Gray iron is suitable for bushings, liners and machinery castings where ease in machining rather than maximum hardness or strength is required.



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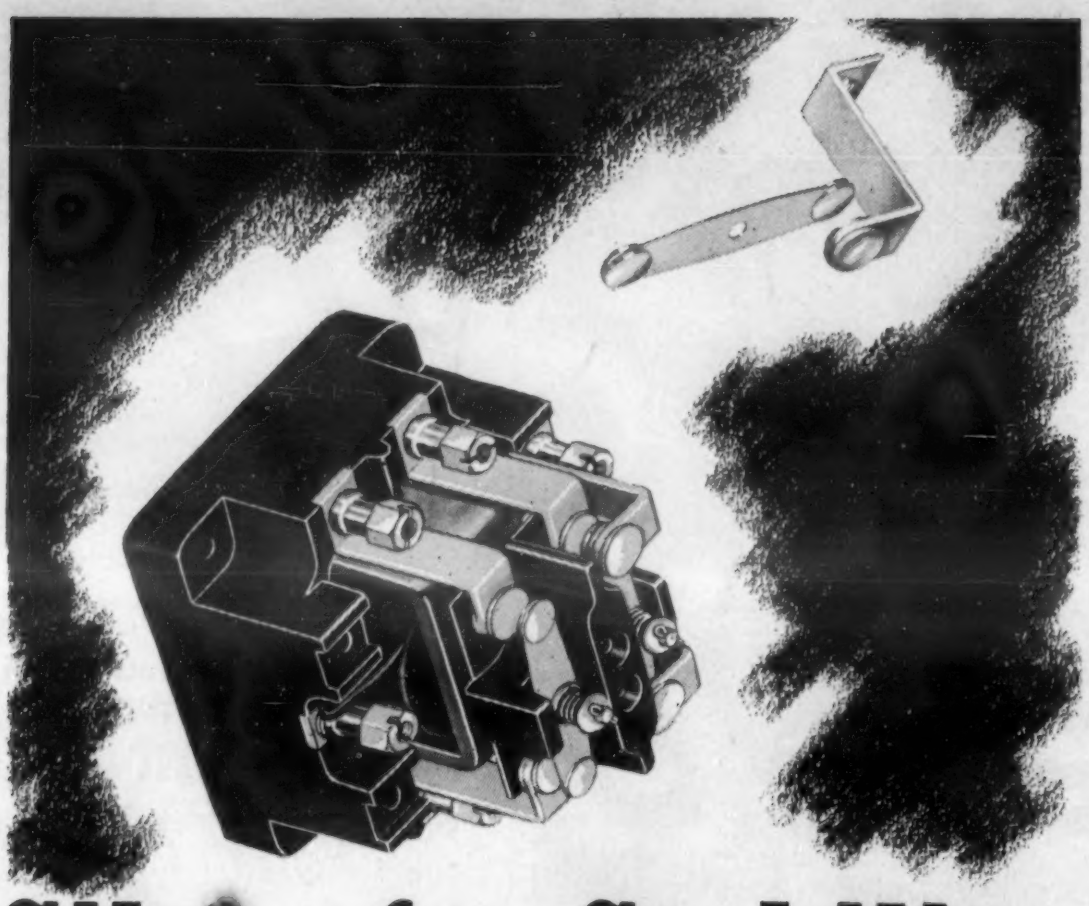

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Manganese bronze centrifugal castings are used for pump liners, shaft sleeves, hydraulic cylinder liners, propeller hubs, blades, gears, worm wheels, etc. Aluminum bronzes are similar in properties, but in addition can be heat-treated.

Centrifugally-cast copper-silicon alloys are applied as rolls, liners, sleeves and tubes. Monel's centri-cast uses include valve-fittings, propeller hubs, engine framing, expansion joints, paper mill rolls, pump liners, etc.

—K. D. Moslander, *Machine Design*, Vol. 14, June 1942, pp. 74-77, 102.

Creep Behavior of Steel

Condensed from "Journal, Iron & Steel Inst."

A study was made of the behavior of carbon steels by means of microscopical examination of test specimens from short-time (tensile) and long-time creep tests. The specimens were tested in a high vacuum over the range 60 to 1750 deg. F. In the majority of cases the stress applied was sufficient to cause rupture. The materials examined had various carbon contents up to 1.14%.

The effect of carbon content was most noticeable in short-time tests, but as the temperature of tests was increased this effect was reduced. In creep tests at 850 deg. F. there was a marked difference in the life of the specimens of certain materials, those of higher carbon showing the greater strength.

At 940 deg. F. and above, the effect of carbon on the life in creep tests was not very noticeable. The alpha-gamma structural change in iron and low-carbon steels between 1300 and 1650 deg. F. caused a marked increase in strength of the material as measured by short-time tests, but in high-carbon steels there was little alteration in properties resulting from this structural change.

The work shows the general weakening of the materials with increase in temperature and describes the general nature of the structural changes set up. The deformed material gave evidence of slip and dislocation as well as recrystallization, spheroidization, graphitization and cracking. The various materials showed these effects to varying degrees, depending on their chemical composition.

The deformation of ferrite occurred by the well-known action of slip, but a new mode of deformation is described in regard to the constituent pearlite. This is referred to as dislocation. It appears that the pearlite can be deformed by a shearing action on a plane inclined to the ferrite and carbide lamellae of the pearlite.

The tests were made principally on high-carbon steels in which recrystallization was not so prominent a factor as in the low-carbon steels described in an earlier paper.

On account of the higher proportion of pearlite in these steels spheroidization and graphitization were important factors. In certain cases spheroidization was seen in even the short-time specimens. Graphitization was an important factor in creep tests made just below the A_1 temperature.

—C. H. M. Jenkins, G. A. Mellor & E. A. Jenkinson, *J. Iron & Steel Inst.*, Adv. Copy, Jan. 1942, 36 pp.

Light Metal Gas Bottles

Condensed from
"Schweiz, Archiv. angew. Wiss. Tech."

Light metals are increasingly used in Switzerland for gas tanks, mainly for 1, 2 and 3.3 liter tanks for oxygen, compressed air, acetylene, and other compressed gases.

The following tests are compulsory: On test specimens of the container material—tensile test, bend test, impact test (all 3 with pieces cut out longitudinal and peripherical), Brinell hardness, fatigue tests, macro- and micrographic analyses, internal stresses, chemical composition, and X-ray examination of the oxide film; on the containers—working pressure, test pressure, appearance of elastic limit at bottom and sides, static tensile test, fatigue test.

The specifications are: Brinell hardness—average 105, min. 95; tensile strength (longitudinal)—average 54,000, lbs. per sq. in., min. 48,500 lbs. per sq. in.; yield point (0.2 per cent elong.)—average 34,000, min. 31,600 lbs. per sq. in.; elongation (longitudinal)—average 16%, min. 14.4%; number of bends—average 35, min. 28; impact strength (notched bar longitudinal)—average 3, min. 2 mkg./cm^2.

The containers with a working pressure of 21,300 lbs. per sq. in. have a test pressure of 32,000 lbs. per sq. in. and shall have a min. elastic limit of 42,700 lbs. per sq. in., a min. tensile strength of 61,000 lbs. per sq. in., and an average tensile strength of 67,500 lbs. per sq. in.

Material	*Composition*						
	Si	Cu	Mn	Mg	Fe	Ti	Al
Lautal	1.6	4.5	0.5		0.4		bal.
Antikorodal	1.0		0.7	0.7	0.3		bal.
Avional D	0.3	3.7	0.5	0.5	0.3		bal.
Avional DTi	0.25	3.8	0.5	0.5	0.3	0.16	bal.

Tests have been made with 4 materials, as tabulated above. Of these 4, "Lautal" is a German product, the other 3 are Swiss alloys brought out successively and representing improvements over Lautal and the respective older types. The best method of fabrication is deep drawing.

The added titanium not only improved mechanical properties but the structure also. Corrosion resistance could be improved by anodic oxidation. Tanks made from Avional are especially recommended for the larger-capacity bottles.

—T. Wyss, *Schweiz. Arch. angew. Wiss. Tech.*, Vol. 7, Nov. 1941, pp. 318-325.

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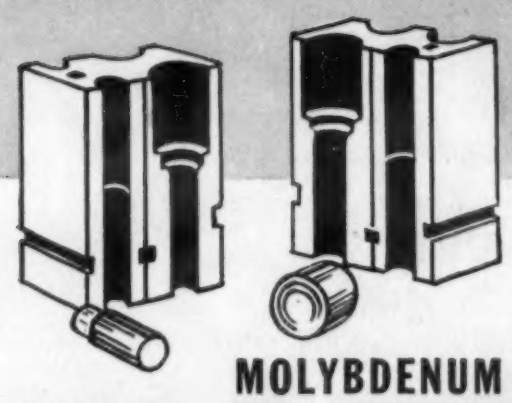

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JESSOP STEELS FOR AMERICA AND HER ALLIES
CARBON · HIGH SPEED · SPECIAL ALLOY · STAINLESS · COMPOSITE STEELS

Non-Metallic Cable Sheathing

Condensed from "The Engineers' Digest"

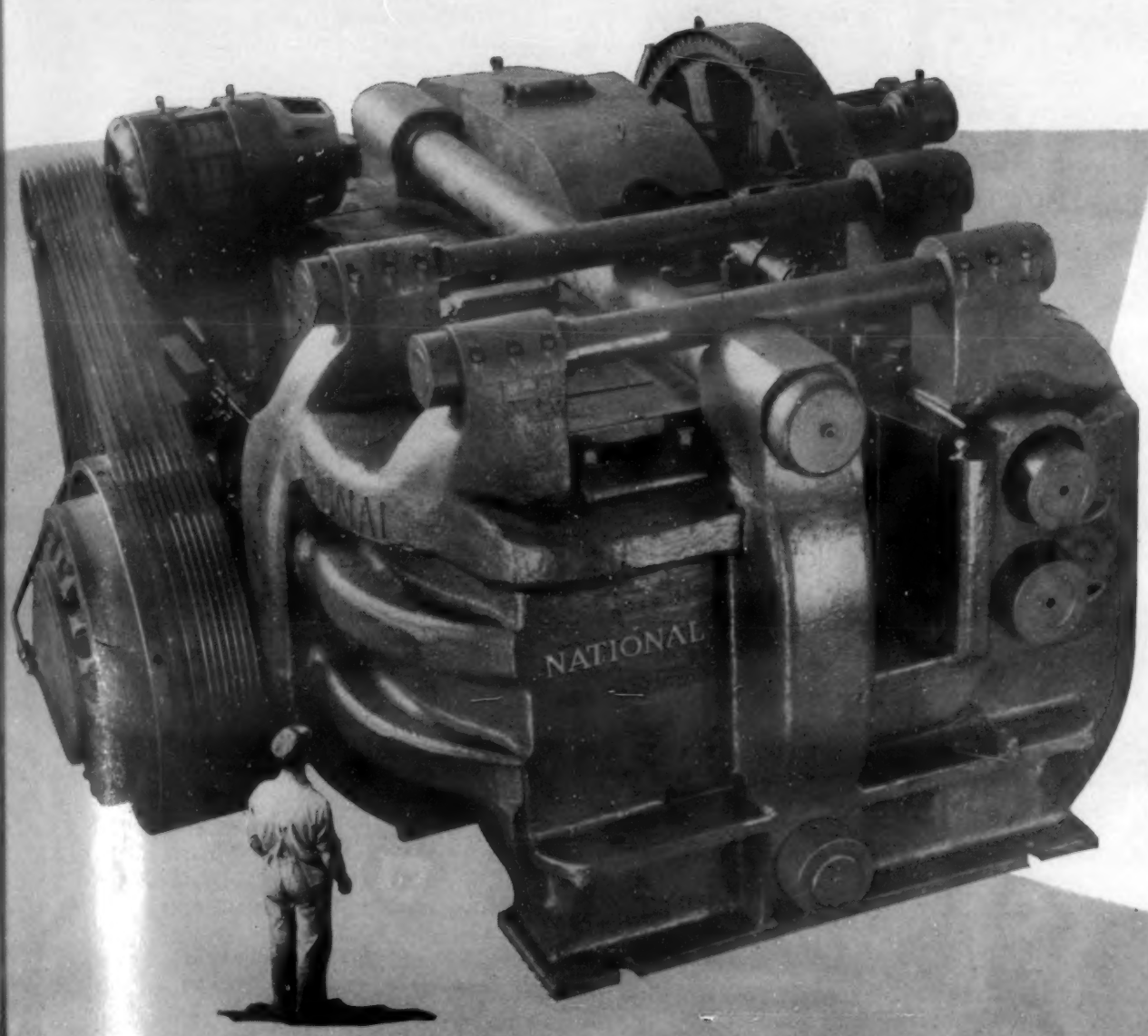
In all previous attempts to replace the lead sheath of underground cables with a covering of synthetic material, a moisture-proof insulation has been applied. Recently W. Rihl & H. Herring developed such a cable with paper insulation of the usual type. This is described in an article in *V. D. I. Zeitschrift*, Vol. 85, May 10, 1941, p. 449.

In 1938 the German State Railway and Siemans and Halske laid a 22-mile length of Pupin telephone cable with sheathing of synthetic material. The high hygroscopicity of paper made laying this cable in the ground a severe test of the synthetic cover. A cable with a lead sheath of the usual type was laid in the same trench beside the cable with the synthetic cover for comparison.

The synthetic cover of the experimental cable (core diam. approximately 0.7 in.) consists of an inner 3/32 in. sheath of "Protodur W" (a mixture of "Oppanol" and carbon) and a 3/32 in. outer sheath of "Protodur H," (a mixture of "Igelit," a polymerization product of vinychloride, and some plasticisers). Between the paper insulation of the core and the inner sheath there is a layer of aluminum-tape and a layer of cotton tape; and between the two synthetic sheaths a layer of cotton and a layer of aluminum tape.

The soft inner sheath protects the cable from humidity. Oppanol, produced from

STEEL CASTINGS



make BETTER forgings possible

Sounds a little inconsistent, doesn't it? For in some applications, forgings and castings are pretty active competitors.

Still the frame of this giant forging machine, designed for producing airplane cylinders, is made of steel castings —for rigidity, for precise accuracy and for economy. The machine is the largest of its kind ever built and weighs over 500,000 pounds.

This is typical of the thousands of jobs steel castings are doing to advance our war production effort—to deliver vastly increased numbers of guns and tanks and ships and planes.

When it comes to building things better and quicker and at less cost, engineers and designers are inclined to look into steel castings FIRST. They require less time to prepare for production. They make available all the desirable properties of steel—strength, hardness, rigidity, resistance to fatigue and stresses and resistance to extremes of heat, cold and pressure.

They often introduce new economies by combining many parts in a single casting—saving finishing and assembly time. They reduce the handling and machining off of needless metal, and make it easy to get weight and strength exactly where they are needed most.

May we suggest that you discuss both old and new production problems with your steel foundryman. Or you may communicate—no obligation of course—with Steel Founders' Society, 920 Midland Building, Cleveland.

MODERNIZE AND IMPROVE YOUR PRODUCT WITH

STEEL CASTINGS

isobutylen by polymerization, is very tough in spite of its softness and its suppleness. It is impossible to handle it in the usual extruding machine, and, therefore, a special machine had to be developed.

As a protection of the comparatively soft inner sheath, a second sheath of a material of great strength, Protodur H, is extruded over the inner sheath. The joints of the wires are protected against humidity by a longitudinally split sleeve from Protodur W, which is closed and connected with the Protodur W sheathes of the cables by welding with heat and pressure.

These sleeves are covered by several layers of fabric tape and aluminum tape. The outer mechanical protection consists of a cast iron connection box of usual design.

Measurements made after the laying of the cables showed that all specifications had been satisfied by the new cable. Since then repeated measurements showed that no deterioration had occurred.

Further information about the use of non-metallic cable sheaths is given by Paul Mentz in *Elektrotechnische Z.*, Vol. 61, Dec. 6, 1940, pp. 1131-1133. Cables of the same design as described above, lying in a water tank or in a tropical test room for two years do not show any deterioration of their electrical qualities. It is expected that the cables will comply with all demands after many years of use, as the synthetic materials show no aging.

Cables with sheaths from polyvinyl-chloride products are especially suitable, where humidity is not very high, *e.g.* in rooms, in drained pipes and canals and as aerial cables. Some aerial cables with impregnated paper insulation and "Protodur" sheaths show only minor variations of their electrical qualities.

Cable sheaths from Protodur have successfully endured cold winter weather. In one plant, the temperature occasionally falls to 0 deg. F., whereas in the vicinity of the machine shop, the temperature rises to 80-110 deg. F. Some runs are exposed to temporary sunshine on outside walls. The electrical qualities are still the same as when the cable was installed. No deformation has occurred to the Protodur sheath under the clips.

—*Engineers' Digest*, Vol 3, Apr. 1942, pp. 152-153.

JOHNSON BRONZE

The BEARING that LUBRICATES itself

Ledaloyl
SELF LUBRICATING
REG. U S. PAT OFF

Oil is the life blood of every motive unit. In order to gain smooth, quiet operation; long, satisfactory bearing life, we must have the right amount of oil . . . in the right place . . . at the right time.

Johnson LEDALOYL bronze bearings provide this type of performance. Evenly distributed over all surfaces of every LEDALOYL bearing are millions of tiny, evenly spaced pores. Each of these pores serve as miniature oil reservoirs. Heat, generated by the turning of the shaft draws the oil from the pores into the bearing area. Thus a thin, protecting film of lubricant separates the shaft from the bearing, reduces friction to a minimum and assures long, satisfactory life. When the shaft stops, the oil is absorbed by the bearing.

Johnson LEDALOYL Bearings are ideal for any place where lubrication is hard to achieve, likely to be neglected, or where excess oil might damage goods in process. A request, will bring the complete story and the actual operating facts concerning LEDALOYL. Write today.

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Service-Cracking of Brass

Condensed from "Sheet Metal Industries"

"Mercury" type cracks generally begin at margins, holes, or ends, then spread over the object. In a test where only the middle part of a brass tube was immersed in 1% $HgNO_3$ + 1% HNO_3, the cracks started from the top of the tube because the mercury had spread to the top by vaporization and capillary action; the cracks were brightly coated with mercury. However, cracks of this type have been observed which begin and end far from any margin.

Pieces that had cracked in the network manner did not form mercury cracks on exposure to mercury, but pieces cracked in mercury disintegrated quite soon in a system of network cracks on exposure to ammonia. Tests on brass cups indicated that the mercury cracks run at right angles to the probable stresses and form oblique zigzag systems when the stresses become complex.

Uniform and simple stresses in brass strip, rod and tube led to no cracks, but soft articles that had been buffed, spinnings, and pressings cracked. Uneven, rapidly changing and asymmetrical stresses appear necessary for cracking.

Season cracking, mercury cracking and undefined cracking in service always seem to be intercrystalline except that the cracks will sometimes cross grains of beta. Since beta is very susceptible to attack by mercury and ammonia, it is suggested that traces of this phase in the grain boundaries of brass may be the points of attack, or, at least, of initial cracking.

Network cracking always seems to be preceded by tarnish. Analyses of these tarnishes, as well as of crusts formed, and of solutions in which brass cups had been immersed, indicated that in all these cases the copper-zinc ratio in the tarnish was appreciably higher than in the brass (for example, cups with 62.5-63.5% Cu gave solutions with 73% Cu-27% Zn). It appears that the boundary product (white lines) may be very zinc-rich, while the general surface product is copper-rich.

—R. G. Johnston, *Sheet Metal Inds.*, Vol. 16, May 1942, pp. 664-666.

Advertisement JULY, 1942

COPPER ALLOY BULLETIN

REPORTING NEWS AND TECHNICAL DEVELOPMENTS OF COPPER AND COPPER-BASE ALLOYS

Prepared Each Month by the Bridgeport Brass Co. "Bridgeport" BRASS CO. *Headquarters for BRASS, BRONZE and COPPER*

Welding With Bronze Is Fast, Economical

In these days when time- and machinery-saving methods are so invaluable, the speed and economy of bronze welding has taken on added importance.

Much less time is required for bronze welding than welding with ferrous rods because the joint is actually made by "brazing" instead of by true welding. As the bronze welding rod alloys melt at much lower temperatures than the steel, cast iron or copper to be joined, it is only necessary to bring the clean base metal to a good red heat for adhesion to take place with the molten bronze. The edges or surfaces to be joined are not melted, but are heated hot enough for the molten metal from the bronze welding rod to spread thinly over the heated surfaces with the aid of melted flux. The bronze adheres to the base metal when solidified, and more bronze is added to obtain the thickness desired. Because only local preheating is necessary in the bronze welding process, warping, cracking and changes in physical properties of the joined metals are lessened.

Despite the fact that bronze welds are usually more economical than iron or steel welds, they are considerably stronger—often, in fact, being stronger than the parent metal.

Further details on bronze welding, together with a description of Bridgeport's comprehensive line of welding rods, are contained in the booklet "Bronze Welding Alloys" which is available on request.

Memos on Brass—No. 30

The manufacture of brass products often requires one or more annealing operations. They should be carefully controlled to produce a temper that best meets the requirements of both cold working and finishing. The grain structure should be kept as fine as possible without leaving the metal too hard for further cold working. A good working knowledge of the annealing process, adequate furnaces, and equipment for cleaning the metal in acid solution and thoroughly washing it are necessary. While insufficient annealing causes difficulty during subsequent cold working, over-annealing may produce a rough surface on the finished article and may even develop small checks. The long experience of Bridgeport's laboratories is available to help fabricators achieve the best annealing results.

Pierce and Carry-Down Operations Require Care to Prevent Rupture

Correct Temper and Observance of Simple Precautions Cited as Necessary If Best Results Are to Be Obtained

Stampings, cups and shells made from sheet metal such as brass, bronze or copper are both very strong and serviceable. They are also extremely economical in regard to the weight of metal used. Nevertheless, thin walls present a problem when it is necessary to attach a screw and the wall thickness is not sufficient for threading. Also, sometimes it is required to solder a tube to the part, and here again the thin wall does not offer much support.

"Drifting" Operation

Metal workers get around this situation by piercing a smaller hole than the intended finished diameter and carrying down the metal to form a shoulder, by means of a punch and die. This operation is sometimes called "drifting." If the metal is not thick enough for a cut thread, a rolled thread is sometimes made.

Preventing Cracked Edges

Where only a slight draw-down section is required, half-hard material (rolled 2 Nos. B & S hard) will prove satisfactory. For deeper draw-downs, the bottom edge will crack or tear. Slight cracks are not objectionable for most conditions.

Where it is essential that breaks be avoided entirely, special precautions should be taken, such as using soft or annealed metal instead of half-hard or hard. Piercing the hole may be the source of the trouble because the piercing operation cuts the metal by pushing the top section and breaking off the bottom one, thus hardening the edge of the pierced hole. When the punch (larger than the pierced hole) pushes through the metal, it naturally stretches the hole and breaks will occur if sharp edges are present. Reaming the hole before drifting will cut off the sharp edges and burrs, and fracture is not apt to occur if the draw-down is short. Piercing the hole in one direction and drifting the metal in the opposite direction may be helpful.

A side outlet made by piercing and carrying down the metal.

For a deep draw-down, it may be necessary to either anneal the metal locally or entirely after the piercing operation, or possibly add an extra drifting operation. Spot or local annealing is expensive and it is sometimes more practical to first bump or draw the metal, then pierce it and follow up by the drifting or carry-down operation.

Cupping and Drawing Of Brass Not Difficult

Fabricators who are faced with the problem of cupping or deep drawing brass for the first time will not find these processes difficult, provided that they use brass of the correct temper, properly designed tools and the right lubricant.

One of the difficulties encountered in drawing brass, namely, retention of metal during cupping, can often be eliminated by careful lapping of the die and punch and the removal of sharp corners.

In cupping brass, the following are a few of the precautions that should be observed: die radii should be relatively large, highly polished in the direction in which the metal is flowing, and free from scratches; holding surfaces should be polished or lapped; pressure should be sufficient to prevent wrinkling and equalized on holding surfaces.

Heavy gauge metal, such as .040 or heavier, generally requires a heavy lubricating oil, such as lard oil or lard oil diluted with other lubricating oils. Lighter gauge metals, .025 or lighter, take lighter lubricants, such as soap water made up from soap chips.

In the selection of brass, too soft a metal should be avoided because it may produce a rough cup which may break off at the corners. A fine-grained brass, resulting from a low temperature anneal, is best where the metal is shaped without appreciable reduction in gauge at the wall of the cup, since this operation requires a very strong metal.

COPPER ALLOY BULLETIN

ALLOYS OF COPPER

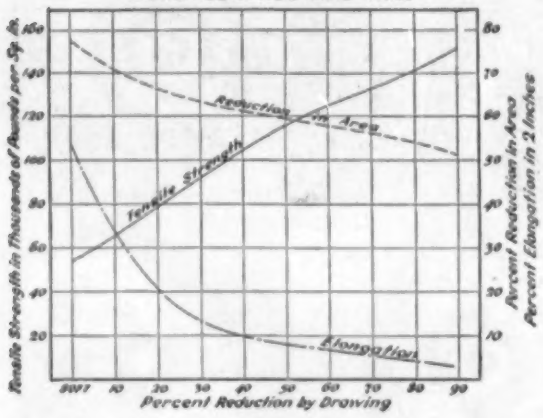
This is the thirty-fifth of a series of articles on the properties and uses of the copper alloys.

COPPER-SILICON ALLOYS

In the June issue of the COPPER ALLOY BULLETIN, the properties and applications of an alloy containing 98% copper and 2% silicon, which is commercially known as Duronze* V, was discussed in this column. This alloy is characterized by moderate tensile strength in the annealed condition and surprising malleability in the hard drawn condition.

This month we will discuss the characteristics of an alloy, commercially known as

COLD DRAWING CHARACTERISTICS OF DURONZE II ROD AND WIRE

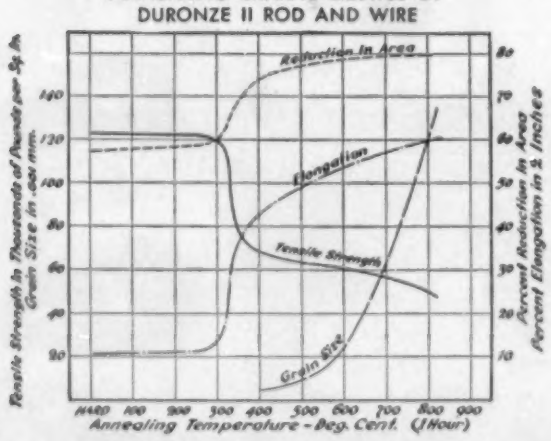


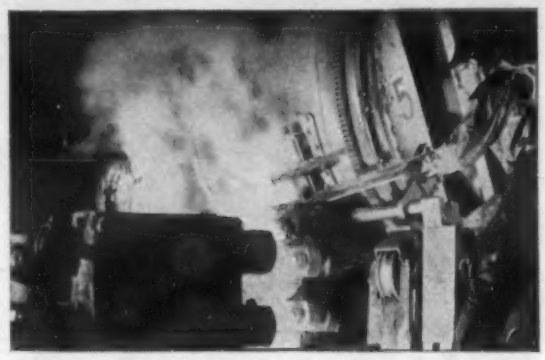
Duronze II, which contains approximately 97% copper and 3% silicon.

As is to be expected, the additional silicon content in Duronze II causes greater hardness and strength with reduced malleability. When annealed at 650° C., Duronze II has a tensile strength slightly under 60,000 lbs. per sq. inch as compared to approximately 44,000 lbs. per sq. inch for Duronze V. Its strength in the annealed condition, therefore, compares favorably with low carbon steel. In Duronze II a copper alloy is pro-

(*Continued in column 2*)

ANNEALING CHARACTERISTICS OF DURONZE II ROD AND WIRE


Tensile Strength in Thousands of Pounds per Sq. In.
Grain Size in .001 mm.
Reduction in Area
Elongation
Tensile Strength
Grain Size
Percent Reduction in Area
Percent Elongation in 2 Inches
Annealing Temperature - Deg. Cent. (1 Hour)



In huge arc-fired kettles such as this Bridgeport is producing high copper alloys for planes, tanks, guns, ships and other instruments of destruction to help America defend her priceless freedom. Every iota of Bridgeport's skill and experience, as well as every moment of its time, is marshalled to the making of copper and copper alloys for victory.

ALLOYS OF COPPER

(*Continued from column 1*)

duced that is both tough and non-rusting, one that lends itself ideally to the manufacture of small tanks and structural members where the strength of steel and the corrosion resistance of bronze are required.

Cold rolled Duronze II sheet and strip of spring temper is used as a substitute for Phosphor Bronze spring metal for making flat springs for electrical switches and contacts. Duronze II can be either hot or cold rolled, or hot or cold forged. It has comparatively high electrical resistance and can be readily spot, seam or gas welded. The physical properties and characteristics of Duronze II are as follows:

PHYSICAL PROPERTIES OF DURONZE II

Condition	Tensile Strength Lbs. per Sq. In.	% Elong. in 2"	% Red. Area
Sand Castings	40–50,000	30–40	40–50
Annealed Sheet and Rod	50–60,000	45–55	55–65
Hot Rolled Sheet and Rod	50–60,000	45–55	55–65
Hot Forgings	55–65,000	40–50	50–60
Hard Drawn Rod	70–110,000	10–25	50–60
Cold Rolled Sheet 4 Nos. Hard	90,000	15–25	50–60

PHYSICAL PROPERTIES OF DURONZE II COMPARED WITH COPPER

Properties	Duronze II	Copper
Melting Point	1025° C.	1083° C.
Density at 22° C.	8.55	8.94
Weight per Cu. In. in Pounds	.309	.3229
Electrical Conductivity	6.5%	97.5%
Electrical Resistivity Ohms per Mil. Foot	189	10.64
Coeff. of Linear Expansion per degree F.	0.0000093	0.0000094
Thermal Conductivity (Approx. % of Copper)	9	100
Tensile Strength Lbs. per Sq. In.—Hard Drawn	90,000	45,000
Tensile Strength Lbs. per Sq. In.—Annealed	55,000	34,000
Modulus of Elasticity	15,000,000	16,000,000
Magnetic Properties	None	None
Rockwell Hardness—Hard Drawn	B85	B50
Rockwell Hardness—Annealed	B80	F40
Duronze II Weighs 4% Less than Copper		
Duronze II Sand Castings		
Tensile Strength	40,000	22,000
% Elong. in 2"	30	35

NEW DEVELOPMENTS

A machine tool vise available in stationary or swivel design has been announced which attaches to a machine tool table with T-bolts and has a ½-inch wide T-slot tongue. Hardened jaws are 1⅛ inches deep and 3¼ inches wide. Maximum opening is 2 inches. Handle is arranged for high speed opening and closing. **(No. 340)**

Double duty washers have been developed which are said to save time, money and vital materials. One of these washers, the maker states, replaces flat and ordinary lock washers in all bolted assemblies. The broad surface is said to afford adequate bearing surface for all requirements and the unique design assures uniform tension. **(No. 341)**

An illuminated magnifier which weighs only 17 ounces has been developed for inspection purposes. The maker claims it can be used almost as easily and flexibly as an ordinary magnifying glass. Lenses available give double and triple magnification. **(No. 342)**

A lubricator for air-driven equipment has been designed to operate in any position in the air line convenient for visibility. It requires only a single regulating valve, and oil is added by removing a simple screw plug at the top. Available in 4/5 pint and quart sizes, the lubricator can be regulated to drop as few as five drops of oil per minute. It can be installed in an ordinary tee in the air line. **(No. 343)**

Power squaring shears, having capacities ranging from 12-gauge to 3/16-inch steel and handling cutting lengths from 4 to 12 feet, have been developed. Features include precision cutting, both as to straightness and parallelism; ball bearing, self-measuring parallel back gage with settings to 1/128 inch; speed of 65 strokes per minute; and flat, straight shearing of narrow strips. **(No. 344)**

A new torsion-testing machine for wire samples to 5.8 inch diameter by 16 inches in length has been developed. The machine applies a motor drive at one end of the sample for twist rotation, while the opposite end is held stationary. The rotating and non-rotating heads are fitted with key-operated checks to hold the test piece. One head is movable along the machine base, the other connects to a speed reducer driven by the motor, a two-speed unit for chuck rotation at 13 to 26 r.p.m. **(No. 345)**

A floating lamp has been announced which is said to require no adjustment, no screws, no time out to adjust lights. It is claimed that a touch will move the reflector to any desired point within a horizontal plane 6 feet in diameter and a vertical circle of 5 feet. Clamps or screws anywhere. Made in incandescent and fluorescent models. **(No. 346)**

This column lists items manufactured or developed by many different sources. Further information on any of them may be obtained by writing Bridgeport Brass Company, which will gladly refer readers to the manufacturer or other source.

PRODUCTS OF THE BRIDGEPORT BRASS COMPANY

Executive Offices: BRIDGEPORT, CONN.—Branch Offices and Warehouses in Principal Cities

SHEETS, ROLLS, STRIPS—*Brass, bronze, copper, Duronze**, for stamping, deep drawing, forming and spinning.

CONDENSER, HEAT EXCHANGER, SUGAR TUBES—For steam surface condensers, heat exchangers, oil refineries, and process industries.

PHONO-ELECTRIC* ALLOYS—High-strength bronze trolley, messenger wire and cable.

WELDING ROD—For repairing cast iron and steel, fabricating silicon bronze tanks.

LEDRITE* ROD—For making automatic screw machine products.

BRASS "Bridgeport" CO.

Established 1865

COPPER WATER TUBE—For plumbing, heating, underground piping.

DURONZE ALLOYS—High-strength silicon bronzes for corrosion-resistant connectors, marine hardware; *hot rolled sheets* for tanks, boilers, heaters, flues, ducts, flashings.

BRASS, BRONZE, DURONZE WIRE—For cap and machine screws, wood screws, rivets, bolts, nuts.

FABRICATING SERVICE DEPT.—Engineering staff, special equipment for making parts or complete items.

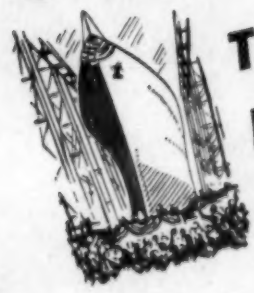
BRASS AND COPPER PIPE—"Plumrite"* for plumbing, underground and industrial services.

*Trade-name.

BRIDGEPORT BRASS

Control...

THE CRITICAL FACTOR IN SHIP LAUNCHING OR STEEL CASTING



WHETHER the ship is launched by burning away anchor plates or by hydraulic trigger in a pit beneath the hull, it's careful *control* of the operation that sends her sliding smoothly down the ways . . . keeps her from running wild and suffering damage before she has made a single voyage.

Steel castings, too, have a "launching point" . . . melting. Only castings poured from a carefully controlled melt can be top quality.

Lebanon has combed the fields of equipment . . . methods . . . and, yes, of men . . . and chosen those that would make the greatest contributions to control. Lebanon is equipped for both arc and induction melting, according to the character of the steel desired. Optical pyrometer readings (illustrated above) are taken of every melt while it is being poured. A high standard of skill and experience must be met by all melting floor personnel.

Since no casting can be better than the melt from which it is poured, the premium on quality is careful control. Lebanon pays that premium in full. That's why Circle Ⓛ Castings are the choice of users who must be *sure* of quality . . . who cannot run the risks of the "pretty good" . . . such manufacturers as Sperry Gyroscope and Waterbury Tool.

Lebanon metallurgists are studying future applications for alloy and carbon steel castings of controlled quality . . . and are ready to discuss significant developments with forward looking organizations.

LEBANON STEEL FOUNDRY · LEBANON, PENNA.

ORIGINAL AMERICAN LICENSEE GEORGE FISCHER (SWISS CHAMOTTE) METHOD

LEBANON *Stainless and Special Alloy* **STEEL CASTINGS**

Physical and Mechanical Property Testing and Inspection • Routine Control and Instrumentation • X-ray and Magnetic Inspection • Spectrographic and Photoelastic Analysis • Corrosion- and Wear-Testing • Examination of Coatings, Surface Measurements • Metallographic Structure and Constitution

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The Inspector Speaks

Condensed from
"Engineering Inspection"

The ubiquitous Army or Navy inspector, most maligned of men however personally charming he may be, has his "say" in an anonymous article, "From the Inspector's Point of View," recently published in a few British magazines. We are reprinting the extracts that follow not only because of the piquancy of the original, but also because there is much useful advice for both inspectors and manufacturing engineers in—and between—its lines.
—The Editors.

The Inspector of Naval Ordnance starts his career at a considerable disadvantage, for Government inspectors are anathema to all manufacturers. The sturdy independence which raises a man from foremanship in a pot and pan factory to the managing directorship of a vast organization is naturally affronted by the knowledge that the Government inspector has considerable power to interfere with production by insisting on a higher standard of excellence than the manufacturer himself considers to be necessary.

It is no uncommon thing to hear it said that, "after all, it's only got to work once," when discussion is taking place about the finish required on something that is to be fired at the enemy. And the retort must inevitably be "Yes, but it must work that time."

An individual who becomes a war inspector must indeed walk warily, for he will be shot at from all angles and, if he succumbs to the sniper's bullet but once, he will find it difficult to come to life again. If he can make it clear that he is there to help in the avoidance of mistakes and failures, and not to act as a damper of enthusiasm and output, then he will not suffer the bitter experience of being quietly sidetracked by the manufacturer telephoning someone higher up in the Department wherever there is a point at issue between them.

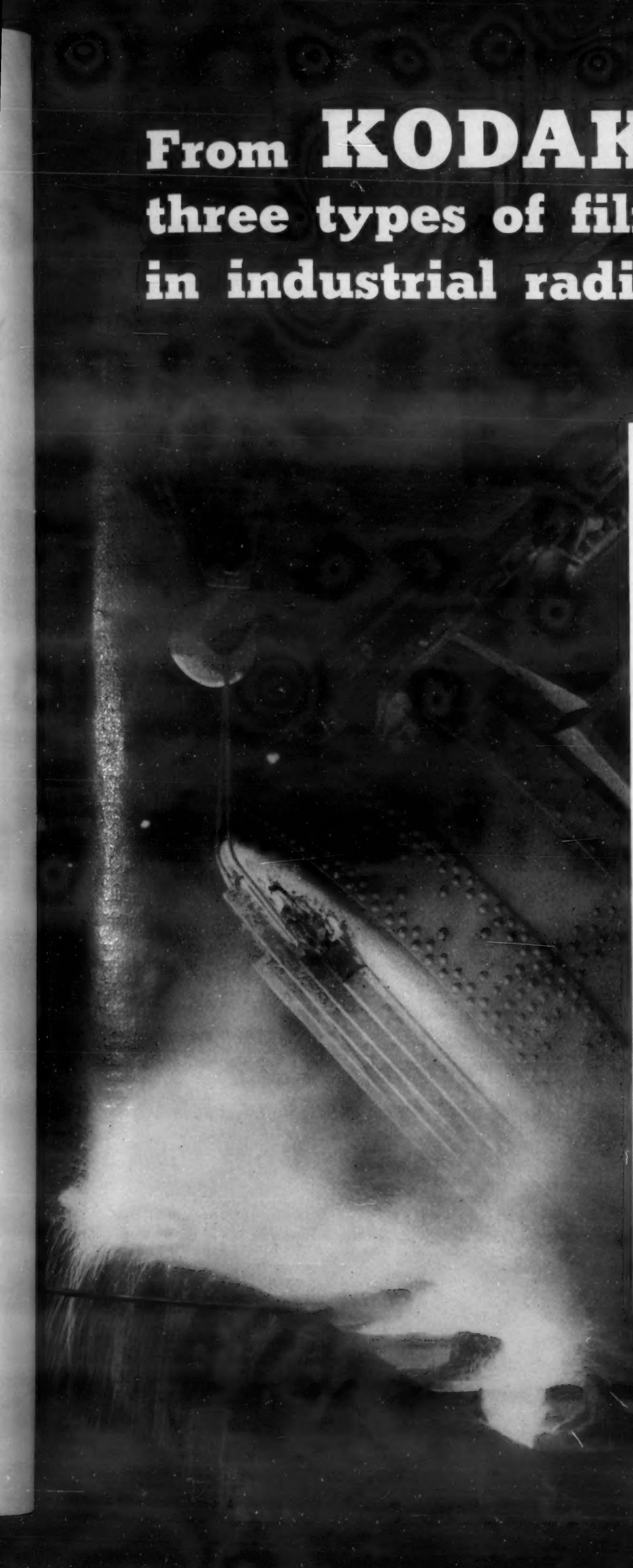
The ideal inspector must be able to talk to manufacturers in their own language, whatever it is (and it will be appreciated that modern weapons include nearly every trade in their production, from plastics to the heavy steel industries). He must be able to express himself clearly, both verbally and on paper, and to hold the balance fairly between the natural tendencies of his own staff to abuse the manufacturer and vice versa.

He must be possessed of a roving eye and the ability or luck to drop on faults that have escaped his underlings' vigilance. He should have a thorough grounding in elementary engineering, physics and chemistry. And, above all, he must have abounding commonsense, good manners, tact and understanding. If, to all these virtues, a sense of humor be added, he will indeed accord with Kipling's specification of a man.

Qualifications of an Inspector

Such individuals, alas, do not grow on bushes, nor do they languish without employment for years waiting for a World War to give them a poorly-paid post in

From KODAK come the three types of film essential in industrial radiography today



Big parts and little—thick and thin—brass, steel, aluminum, magnesium . . . the products being inspected radiographically today are quite unlike one another. The facts to be determined also vary. Exposures are made with kilovoltages ranging from 5 to 1000 . . . and with gamma rays from radium. This means that there can be no one "standard" film. Three distinctively different types are needed—Kodak provides all three.

KODAK INDUSTRIAL X-RAY FILM, TYPE A
. . . primarily for light alloys

Has fine grain, high contrast, and is particularly suitable for low-voltage radiography of aluminum and magnesium . . . and million-volt radiography of steel.

KODAK INDUSTRIAL X-RAY FILM, TYPE F
. . . primarily for the radiography, with calcium tungstate screens, of heavy steel parts

Has the highest available speed and contrast when used with calcium tungstate intensifying screens. Also used for gamma radiography with lead-foil screens.

KODAK INDUSTRIAL X-RAY FILM, TYPE K
. . . primarily for the radiography, direct or with lead-foil screens, of lighter steel parts

Has the highest available speed in direct exposure . . . when used with lead-foil screens at higher voltages . . . and, for heavier parts, with gamma rays.

* * *

Kodak began its industrial radiographic research back in 1927, and the knowledge acquired in this experience may be helpful to you in your particular application. Write Eastman Kodak Company, *X-ray Sales Division*, Rochester, N. Y.

The new booklet "Kodak Products for Industrial Radiography" is available upon request.

Government employ; they are not likely, therefore, to be found in the Inspection Department. The perfect inspector is to be found in Heaven only.

Fortunately, much can be done by lesser mortals, whatever their qualifications, if they are determined to help the war effort first, last, and at all times. With this simple thought as a guide, it will be possible to avoid the pitfalls that lie on all sides.

There is the danger, for example, of making a god of production for production's sake, of being stampeded into sanctioning a departure from design by the urgency of the demand for the weapon, without considering to the full the implications of this departure. He is a strong man indeed who will stop an assembly line employing a thousand men because the products of their work are unsatisfactory; but this may have to be done, whatever the effect on the subsequent relations between the management and the Inspection Department.

In war there is no time to make up ground lost in the idle days of peace. The fighting Services demand a number of weapons; there is no time to dally while the job is tested and proved to be a "production job"—the order is placed, and manufacture begins. Sometimes it is found that there are discrepancies and errors in drawings and specifications, that the designer has not fully considered the manufacturer's angle, and that the gages ordered for inspection purposes will not be ready until after the contract is completed.

All these and many other problems are thrust at the inspector by insistent manufacturers, who must keep the wheels of their factories turning, and who would rather do anything than commit that most heinous of crimes—"holding up production." Decisions must be made, if not by the local man, by the designer himself, who is loth to be stampeded. The inspector must be on the job, coaxing decisions out of his superiors and keeping the manufacturer informed and encouraged.

But who encourages the inspector?

A Perpetual Deficit

It is indeed a thankless task, the results of which can never be gaged. The goal that the inspector must strive to reach is that of hearing no complaints from the fighting men who use the weapons and this, alas, can never be attained. There are days when reports reach him of stores that failed — it may be only a small percentage of the total number, but there will be more said about the few that fail than about the nameless many that function; and so the unhappy inspector can achieve no satisfaction.

Never does he hear from sea or the front that such-and-such ordnance is a howling success, nor do those in authority feel it necessary to encourage him by accounts of successes. There should be no failures; but there cannot be more than 100 per cent success, and so the balance sheet will always show a deficit.

So give a pause for a split second, you fighting men, when next a weapon fails, and remember that the fallibility of human nature is such that perfection can never be obtained.

Let there be appreciation of the 999 successes, and not too much emphasis on the one that failed, and if you have a friend in the Inspection Department — drop him a line and tell him how you use the weapons that he tries so hard to give to you, accurate in performance and above all, safe to handle.

We think of you at all times — think of us a little, and forgive us our trespasses.

—"A. I. N. O." *Engineering Inspection*, Vol. 7, Jan./Mar. 1942, pp. 24-26.

Non-Destructive Testing

Condensed from "Metal Treatment"

Non-destructive tests may be defined as a means of proving particular qualities of a material without impairing its usefulness for the service for which it is intended. The results obtained from such tests are in many cases capable of precise interpretation. In other cases the qualities they are designed to prove can only be assessed by inference, and in this respect they are of a less positive nature than destructive tests which usually give a definite result.

Non-destructive tests are in general applied to finished materials in order to detect defects, flaws, and other irregularities, and are particularly suitable for the testing of castings and welded structures, as well as being extremely useful in supplementing ordinary destructive tests in other forms and types of material.

Acoustic Tests

The striking of a piece of metal with a hammer in order to determine if it "rings true" is a very old test. A simple refinement of this sound method of testing in recent years has been the use of a medical stethoscope fitted with a rubber cap over the conical end. This instrument is pressed against the part to be tested which is then lightly struck by a hammer.

A casting or welded structure being so tested will have a natural vibration, which is first ascertained. A similar sound is obtained on striking parts free from defects, but when a part is reached that contains a defect or flaw, and therefore a discontinuity, a high-pitched reedy sound is increasingly obtained occurring in the primary period of the sound.

The stethoscope method is essentially a qualitative test. It is said to be particularly suitable for determining lack of fusion at the bottom of the vee and along the scarf of a weld, and is best applied to welds in straight pipe lines and large pressure vessels having long seams as, in both cases, the sounds resulting from the vibrations are more uniform than those obtained from more complicated welds, and consequently differences in sound due to flaws are easier to detect.

During recent years attention has been given to the possible application of ultrasonic waves in the non-destructive testing of metals. The most important method of producing supersonic waves is that of converting high-frequency electrical vibrations into powerful mechanical vibrations, and suitable methods have been developed for enabling ultrasonic vibrations with frequencies up to 5×10^5 k Hz. to be produced. Various types of high-frequency generators and high-frequency detectoscope generators for measuring the flow of ultrasonic waves through metals have been developed during recent years for commercial and practical use.

When ultrasonic waves are used for the non-destructive testing of castings or welds for blowholes, cracks, flaws, etc., the generator is placed close to the part to be inspected and the position of the defect recorded by the detecting instruments. When compared with the radiographic method of examination, the outstanding advantages of the ultrasonic method of non-destructive testing is its ability to determine defects that do not represent a sufficient change in density to be revealed by X-rays, and also to deal with cross sections of metal that could not possibly be penetrated by X-rays or even gamma-rays.

In this latter respect this method of testing might prove suitable for the examination of large steel ingots. As a test method, however, it is slower than radiography and can only be used to examine one part at a time.

Practical applications of the familiar magnetic powder method of engineering parts are the identification of surface cracks and non-metallic inclusions in castings of steel and cast iron and also of surface flaws in drawn, forged, pressed or rolled parts, as well as surface cracks resulting from grinding or hardening. In welds fine cracks at or near the surface can also be identified and thin welds can be inspected.

In using the method to examine the vicinity of rivet-holes for cracks, copper conductors are placed in the holes, and the spaces between the holes tested in the usual manner after magnetization. Fatigue cracks can also be detected in their early stages if the method is applied without interrupting the fatigue test. When drawn or rolled rods, tubes or wires have to be examined, circular magnetization is necessary, and this is best effected by passing the current through the specimen to be examined.

The success of the magnetic powder method of testing depends on the proximity to the surface of the faults or flaws to be detected. Where such flaws are more deep-seated, an induction method is used in which irregularities in the permeability of the material under test sets up a distortion of the magnetic field outside the material. For detecting flaws in this manner, alternating current test methods have been developed in which the parts to be tested, bars, tubes and rods up to 3½ in. diam. are passed slowly through special coils.

Radiography

In radiographic methods of testing, use is made of the powers which X-rays and gamma-rays have of penetrating opaque bodies. The gamma-ray method of testing has a greater simplicity in operation than the X-ray method, as no complicated apparatus is required, a film being placed behind the object to be examined and the radium or radium emanation being placed in position at a definite distance from the film and left there for a suitable exposure time.

Many structures can be examined at one time, due to radium radiating gamma-rays in all directions spherically, whereas with X-rays only one examination is possible at one time due to such rays being in the form of a beam. Gamma-rays have also a greater penetration, and steel structures up to 10-11 in. thickness can be quickly examined, as compared with 4½ in. with X-rays.

The disadvantages of the gamma-ray method of testing, as compared with the X-ray method, is the lack of general availability of radium and the longer exposure times required, although the latter disadvantage can sometimes be compensated for by simultaneous radiography. The X-ray method is the more generally used of the two radiographic methods, although both methods have a wide application in foundries for the examination of ferrous and non-ferrous castings and in engineering works for the examination of welds.

—J. W. Donaldson, *Metal Treatment*, Vol. 8, Autumn 1941, pp. 2-8.

Measuring Furnace Atmospheres

Condensed from "The Iron Age"

The "Ranarex" analyzer described in this article is basically a device for measuring the specific gravity of an atmosphere. The specific gravity of an atmosphere is related to its composition.

The apparatus consists of an upper and lower impeller. The lower impeller draws in a sample of the atmosphere. The sample is set in rotation and creates a torque on the companion impulse wheel, located in the same chamber. The upper impeller draws in a sample of ordinary air, rotates it in the opposite direction of the gas sample and creates a torque in its impulse wheel.

The torque set up in the lower impulse wheel is proportional to the gas density and is compared with the torque in the upper impeller. The difference between the opposing torques is transmitted through a linkage arrangement to a pointer moving over a scale. Gas and air samples are brought to the same temperature.

The operation of the instrument with the more common atmospheres is as follows: For atmospheres prepared from natural gas, coke oven gas and certain others the sum of the carbon monoxide + the hydrogen + methane or per cent of combustible, is proportional to the specific gravity.

In some cases it is advisable to remove carbon dioxide by incomplete combustion. The action of the instrument in such cases is similar to that for partially-burned fuel gases.

In some instances gas and air are mixed before combustion. The air-gas ratio may be determined by measuring the specific gravity of the mixture before combustion.

Dry producer gas is produced by passing air through relatively pure carbon. Theoretically with dry air and pure carbon, an atmosphere of 34 per cent Co and 66 N_2 is produced, but actually the analysis is about 25 per cent NH_4, 3.0 CO_2, 28.5 CO, 3.25 H_2, and 65 N_2. The specific gravity of this is 0.957. If the carbon dioxide content increases, the specific gravity will rise.

Atmospheres for brazing are prepared by cracking hydrocarbon fuel gas in the presence of air and steam. If the hydrogen is high the specific gravity will be low.

An atmosphere of 75 per cent H_2 and 25 N_2 suitable for bright annealing stainless steel may be made by cracking dry ammonia at high temperatures. If complete cracking is not desired the per cent dissociation may be measured from the specific gravity.

To produce a less costly atmosphere, cracked ammonia is burned with a deficiency of air to remove the hydrogen as water vapor and to dilute gas with nitrogen of the air. Depending on requirements, there will be an optimum specific gravity, making the type of control instrument described directly applicable.

—Franklin B. Leslie, *Iron Age*, Vol. 149, Mar. 5, 1942, pp. 60-62.

Deep-Etch Macro-Inspection

Condensed from "The Iron Age"

Deep etching reveals relatively large areas in a short time and a fairly accurate opinion can be had as to uniformity, location of segregated areas, decarburized areas, slag and oxide inclusions, gas pockets, etc. After etching any area can be sectioned and examined microscopically for more detailed information.

For most purposes a solution of 1:1 C.P. hydrochloric acid is satisfactory. The acid solution should be heated to between 176 and 195 deg. F. before placing the part to be etched in it. Grease or oil should be removed.

Sometimes only a few seconds are required for etching while other cases require several hours. In examining S.A.E. 4615 bar steel, 1 hr. was required. Forgings can be etched to show grain flow in from 15 to 60 min. Carbon steels require less time than alloy steels, and bolts, rivets and sheets only a short time.

In instances of broken parts, care should be taken not to over etch. After the part is suitably etched, it should be washed in hot water, being rubbed at the same time with a plater's brush.

Additional methods developed for certain investigations are of use in specific cases. Etching with concentrated hydrochloric acid reveals soft spots in carburized steel as white areas on dark surface. The following solution is equally useful for forgings: 9 parts hydrochloric acid; 3 parts sulphuric acid; and 1 part water. For high chromium steels a good solution is 15% sulphuric acid and 1% bromine.

After etching, areas low in carbon appear light in color compared with those of high carbon content. Slag inclusions of the fusible silicate type stand out as white, sharply-defined areas surrounded by dark areas. Inclusions of the oxide type appear black.

Grain flow can be determined by sectioning and deep etching, either hot-forged or cold-upset parts. Whether the steel is forged or pressed, the grains are elongated in the direction of the flow.

—Geo. W. Walker, *Iron Age*, Vol. 149, Apr. 2, 1942, pp. 45-51.

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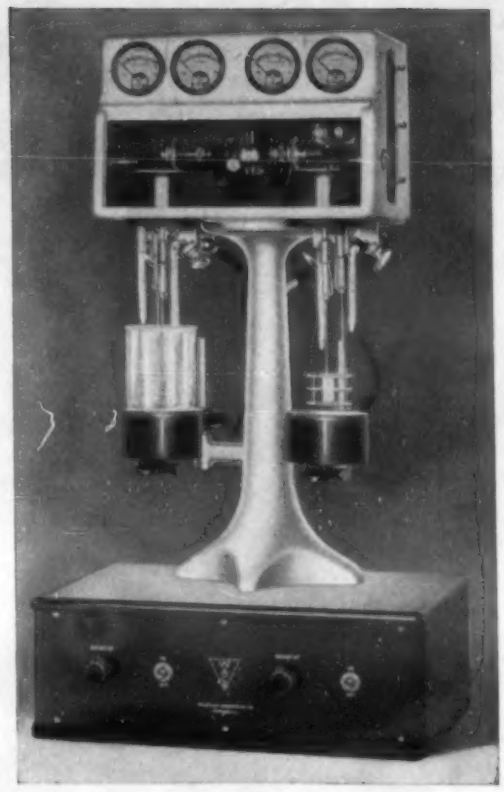

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